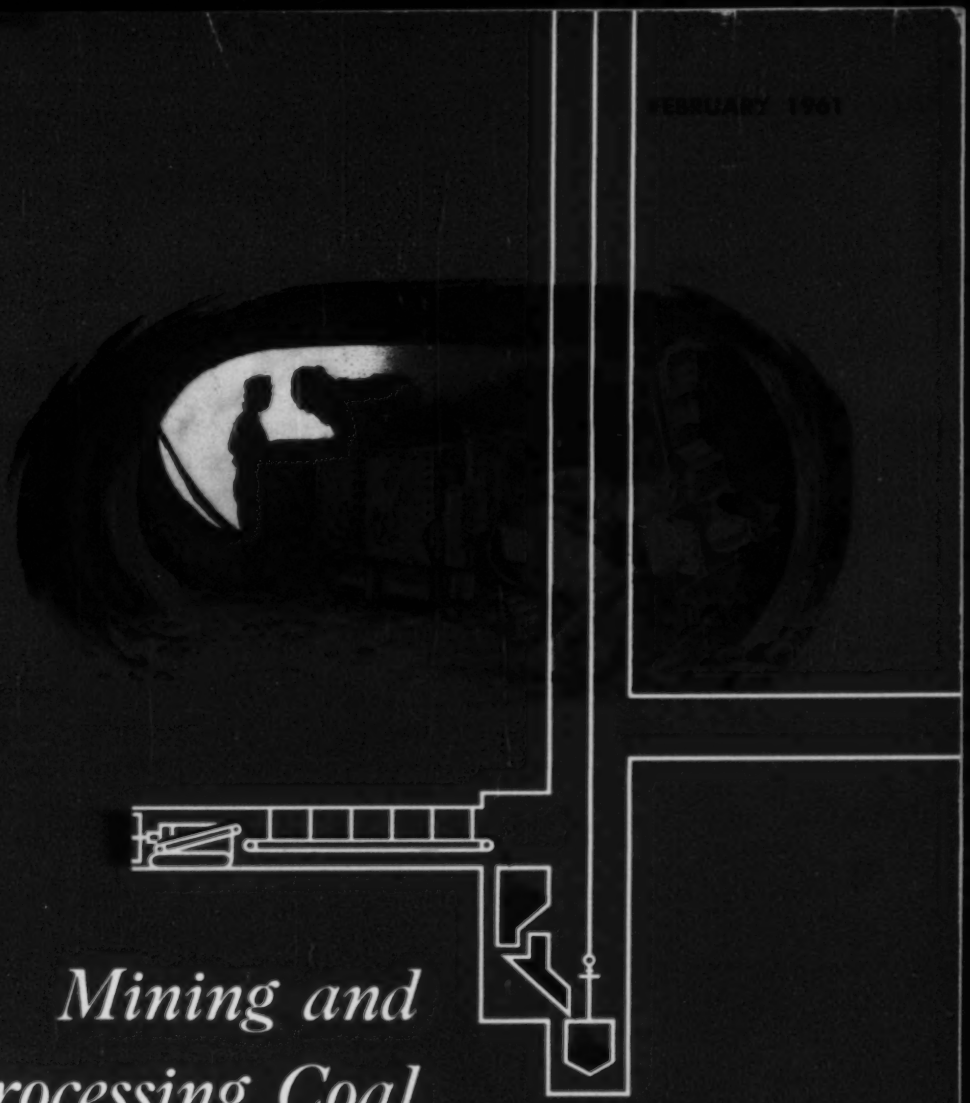
AUTOMATION

FEBRUARY 1961



Mining and Processing Coal

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Using Patent Literature Effectively
- Making Parts from Wire and Strip
- Organizing to Reduce Costs
- Practical Guides to Power Cylinder Application

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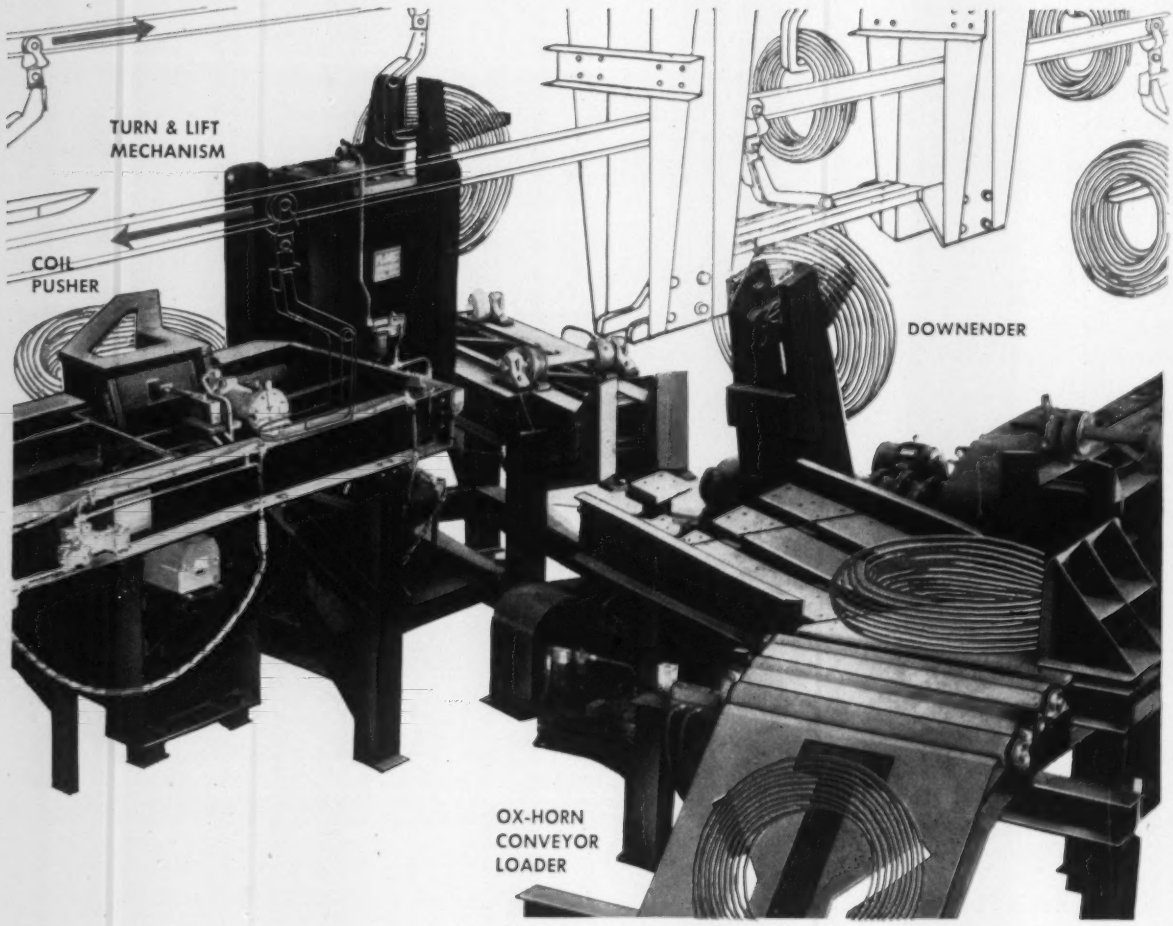

another example of Planet Versatility...

COIL HANDLING SYSTEM LOADS AND UNLOADS EXISTING CONVEYORS AUTOMATICALLY

. This automatic coil handling system is an example of how *Planet Versatility* helped one of America's largest steel mills modernize its 10-inch bar mill to handle larger, 2000-pound bar coils . . . and save money by designing the coil handling equipment to load and unload *existing* conveyors.

A red-hot, 2000-pound bar coil is transferred from an existing drag-chain conveyor to the automatic trolley conveyor loader by a single arm coil pusher. The coil pusher deposits the coil on a drop table which, when lowered, leaves the coil hanging on one arm of a turn and lift mechanism. As this machine revolves 180 degrees it lifts the coil into position to be engaged by a trolley conveyor hook and, at the same time, lowers its other arm to receive the next coil. After cooling on the existing trolley conveyor, a downender removes the coil and sets it on a slider bed on which it is indexed into a banding position. The coil is then transferred onto an existing ox-horn conveyor. *The entire system operates on a 15-second cycle and is completely automatic.*

This automatic coil handling system is more evidence of Planet's versatility . . . its ability to engineer, manufacture, and erect automated systems which solve the most perplexing production, materials handling, and automation problems. Planet has automated production lines, built bulk and unit materials handling systems, designed and erected complete plants . . . and Planet systems are found in the plants of leading manufacturers in almost every industrial classification.

Write or phone to have a Planet engineer demonstration how "PV" can help you . . . you'll find *it pays to plan with Planet.*

912

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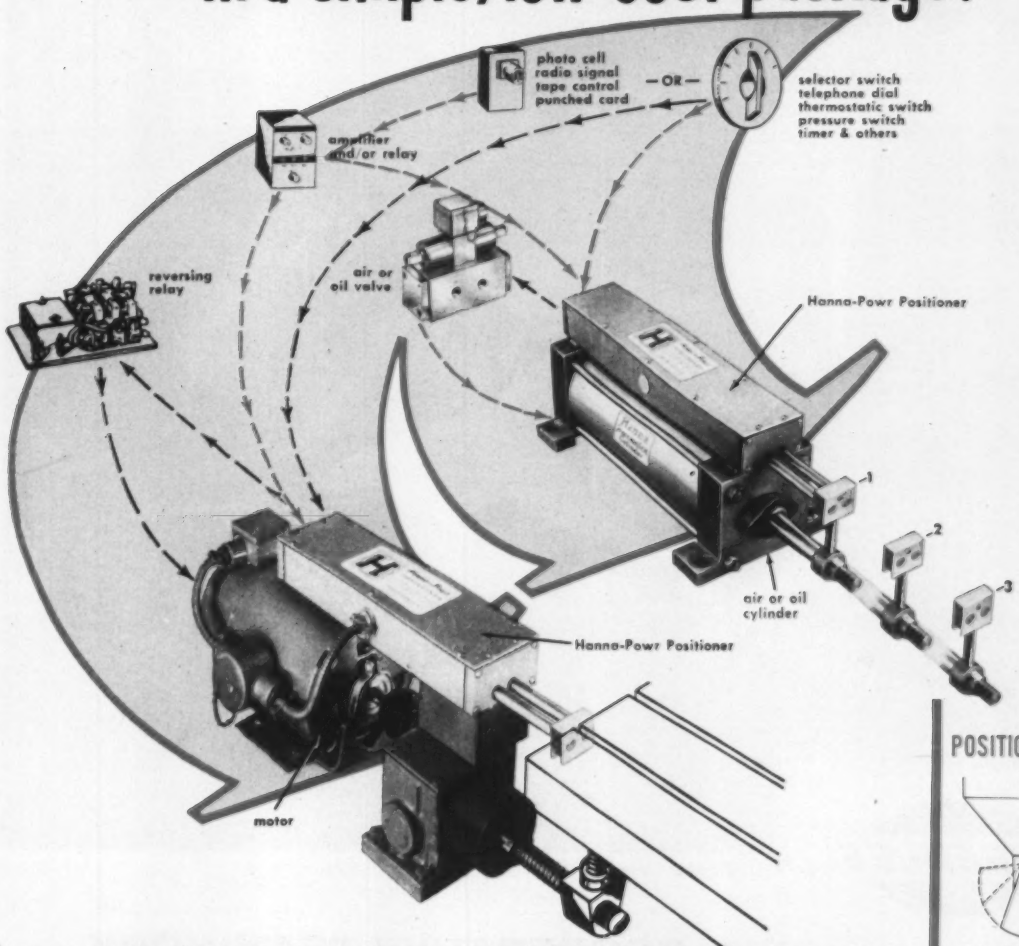
BRAND NEW IDEA... multiple positioning in a simple, low cost package!



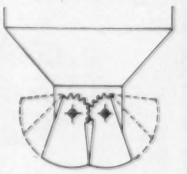
HANNA-POWR® POSITIONERS

THE NEW HANNA-POWR POSITIONER is a simplified, low-cost servo-mechanism used with air or hydraulic cylinders, electro-mechanical or other power drives to responsively achieve predetermined positions. The POSITIONER will also feed a signal to a read-out station to indicate the position point. Controls, such as selector switches, timers, thermostatic switches and others, feed signals to the POSITIONER for station selection—as many as 14 per foot of stroke. Infinite variations in positions are possible by simple movement of the adjustable limit switches. Stroke lengths may vary from a few inches to several feet to suit each application.

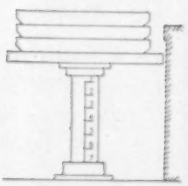
HANNA-POWR POSITIONERS save the time of designing special controls and cams, offer convenience of installation with one simple mounting for a group of controls, and cut maintenance costs by protecting all controls in a sturdy, dust-tight housing.

Your individual problems will suggest many uses for the HANNA-POWR POSITIONER. For more detailed information call your nearby Hanna Representative, (See "Cylinders" in the yellow pages), or write us for Catalog 500.

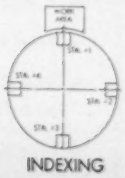
POSITIONED POWER



GATE POSITIONING



MULTIPLE POSITIONING OF LOADS



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60 Years' Experience In Building The Finest Cylinders, Valves and Other Hydraulic and Pneumatic Equipment

Hanna Engineering Works

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MACHINES DESIGNED WITH THE FUTURE IN MIND

PRODUCTION MACHINERY
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- Special Purpose Machines
- Transfer-Type Processing Machines
- Multiple-Spindle Drilling and Tapping Machines
- Six and Four-Spindle Automatic Bar Machines
- Die Casting Machines
- Trim Presses
- Woodworking Machines and Tools
- Hydraulic and Hand Tools

COOPERATIVE TEAMWORK MAKES THE DIFFERENCE

Through every phase of the construction of a Greenlee transfer machine, Greenlee engineers maintain a close contact with you, the customer. They are strong on the buyer's viewpoint . . . know what cost-conscious management wants. They stay on the job from the time of initial planning until your machine is operating at full efficiency. This last phase—the proving out period—is especially important. Greenlee men are extremely helpful in bringing your machine up to full production . . . training your operators to keep it producing profitably. Call Greenlee. Let them show you how cooperative teamwork can benefit you.

GREENLEE BROS. & CO. 1943 MASON AVE. ROCKFORD, ILLINOIS

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FEBRUARY 1961
Vol. 8 — No. 2

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AUTOMATION

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automation outlook

HORSE SENSE

WHY DOES A CONSUMER decide to buy a foreign product? Two main attractions seem to predominate. On one hand is the attraction of better quality or more serviceable product at an equivalent price while on the other is an equivalent quality or serviceable product at a lower price. His decision to buy such products constitutes a direct control over the destinies of companies and jobs.

In fact the same is true of all products. If the consumer concludes that the price is too high, the market and jobs wither. Malcolm L. Denise, vice president-labor relations at Ford reminded us again in a recent talk at the University Press Club of Michigan that the consumer is king in a free-enterprise economy. All too often the volume of post-mortem statistics on business obscures this fact, but it remains basic.

In refreshing memories on a few such vital facts of life, Mr. Denise made it pretty obvious that those who talk of automation's effect on jobs are putting the cart before the horse.

". . . There simply is no escape from the proposition that wages and benefits and contributions and taxes are costs of production. If management fails in its duty to control costs—if it does not keep the cost of doing business at a level which enables the business itelf to grow and prosper—then it fails utterly in its responsibility to customers, stockholders, public, community, and employees alike."

In spite of some commonly held theories, business management must heed the discipline of the market or fail. The effect of market demands and costs is a relentless pressure for increased efficiency in production. Said Mr. Denise, "Automation is one manifestation of the search of doing things better, doing them more efficiently, doing them more effectively . . ."

To talk overmuch of automation's effect on employment rather misses the whole point. Its real job is to create or save business. Since the choice is usually to increase efficiency or close down, the fact is that automation comes into the picture after it has become obvious that trouble is at hand. "Nobody can measure it in a dynamic economy," Denise stated. "To begin with, it is not possible even to get a complete and meaningful count of people immediately out of work as the direct result of automating operations . . . Clearly, we cannot use as a basis the employment level on the affected operations prior to automation. To do so would require us to assume that other unrelated factors had not affected employment in the meantime, and, even more fallaciously, that buying decisions of customers are not influenced by the relative values available to them."

His conclusions provide some real food for thought. "Despite all the publicity about automation, and despite the vast amounts of capital invested in new plants and equipment, unit costs have risen. They have risen because improvements in output per manhour worked have been substantially outstripped by the steady advance in the cost of an hour's work. It is high time for a cost slowdown. Otherwise, more and more workmen . . . are apt to find that, through the decisions of consumers, their jobs are being replaced by jobs abroad, as so many already have been."

Horse sense says let's get the cart properly hitched and make mileage where it counts.

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BPA NBP

...Fluid Power news

OILGEAR 40 Years of Fluid Power

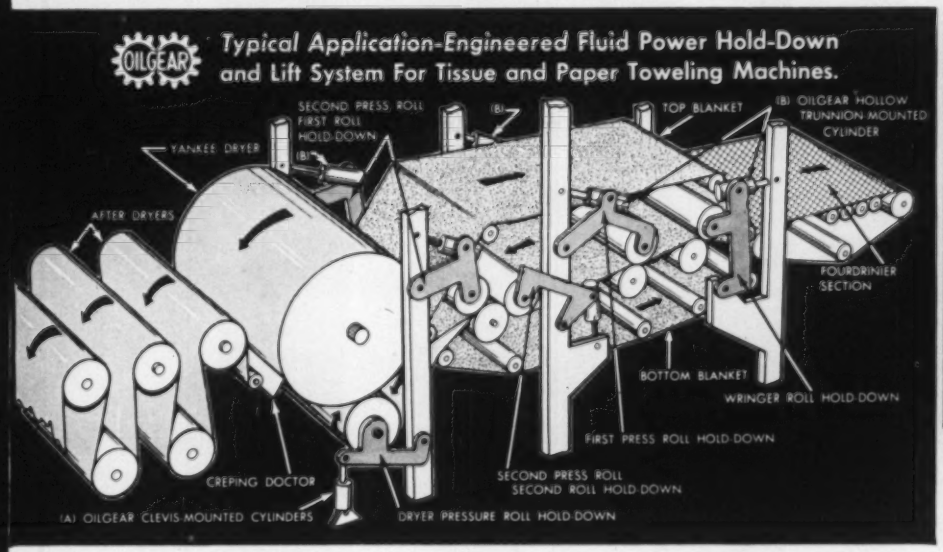
From Oilgear *Application-Engineering* Files

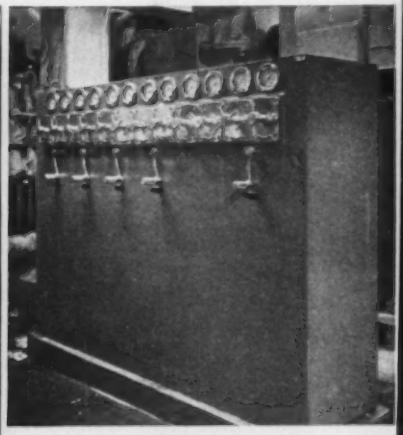
HOW OILGEAR HOLD-DOWN AND LIFT SYSTEMS INCREASE ROLL LIFE—IMPROVE PRODUCT QUALITY

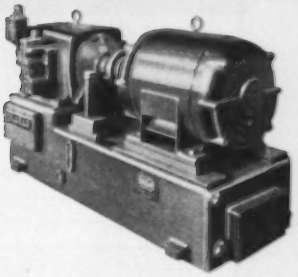
USER: *Scott Paper Company, Chester, Pa.; Everett, Wash.; Mobile, Ala.; Fort Edward, N.Y.*

PROBLEM: To supply hold-down and lift systems for rolls on paper machines, paper coating machines, super calendars, laminating and similar processing machines — that can be accurately controlled from a simple remote control panel.

USER REQUIREMENTS: 1. Provide constant, uniform, preset roll pressures. 2. Smooth lowering and/or forcing of pressure rolls downward to avoid damage, such as fracturing or flatting. 3. Fast, easy, positive selection of such functions as "Lower," "Hold Down," "Release," "Lift," "Hold Up," "Off." 4. Accurately, infinitely vary the pressure on either end of each roll independently over a wide range, at any time, to balance the opposing forces created for most efficient machine operation and product quality. 5. A direct-reading, constant, visual indication of the pressure and force exerted on either end of each roll. In addition, the systems must be simple . . . clean . . . easy to install and maintain . . . facilitate replacement of worn rolls . . . trouble-free, dependable, heavy-duty, for continuous, 'round-the-clock operation.







Top Photo: One of the Oilgear Hold-Down and Lift System Control Panels as installed with each of Scott Paper Company's two, new tissue machines in their Southern Division Mill, Mobile, Ala.—symbolized in the schematic drawing, left. Daily production from these machines averages 200 tons of Scott's bathroom tissues, toweling and wipers for household and industrial use. **Right:** A typical Oilgear Heavy-Duty "**Power-Pak**"—Variable Displacement Pump, electric motor drive, and reservoir base — used with Hold-Down and Lift Systems.

SOLUTION: *Oilgear Application-Engineered Hold-Down* and Lift Systems consisting of Oilgear Heavy-Duty, Constant or Variable Displacement Pumps that supply *Fluid Power* to Oilgear "Custom-Quality" Cylinders through separate Oilgear Valves on a remote control panel — provide smooth, positive motion and steady, preset holding pressures. Cylinders can be mounted directly, or through mechanical linkage, to pressure roll bearing ends. Simplicity of pump drive and installation keep machine cost at a minimum. Remote Control Panel provides fast, positive selection of all functions — operator can "Lift," "Hold Up," "Release," "Lower," "Hold Down" — at any time; accurately, infinitely vary pressure on either end of each roll independently, and have constant, direct-reading, visual indication of pressure and force being exerted at bearing ends of *each roll.*

ONE USER STATES —*"The control panel indication is so accurate that a worn, 'off-balance' or out-of-round roll can be readily detected."*

Another User Reports — *"Oilgear is far superior to other systems . . . direct gage readings have enabled us to experiment with varying degrees of pressure on the rolls, so that we can operate with less pressure than we hitherto thought feasible. This has resulted in improved product quality and longer roll life."*

Oilgear is no "stranger" in the paper industry . . . other Oilgear Linear Drives are in operation on pulp log splitters and pulp baling presses. Similarly, the highly efficient, long-life, Oilgear Heavy-Duty Variable Speed Rotary Drives are compiling enviable records on special purpose paper machine sections . . . on complete paper machines . . . on multi-color printing press drives . . . or unwinder and winder drives . . . on laminating and coating machine drives. It's well worth your while to consider Oilgear — *"for the lowest cost per year!"*

For practical solutions to YOUR linear or rotary motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

1598 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code — 414

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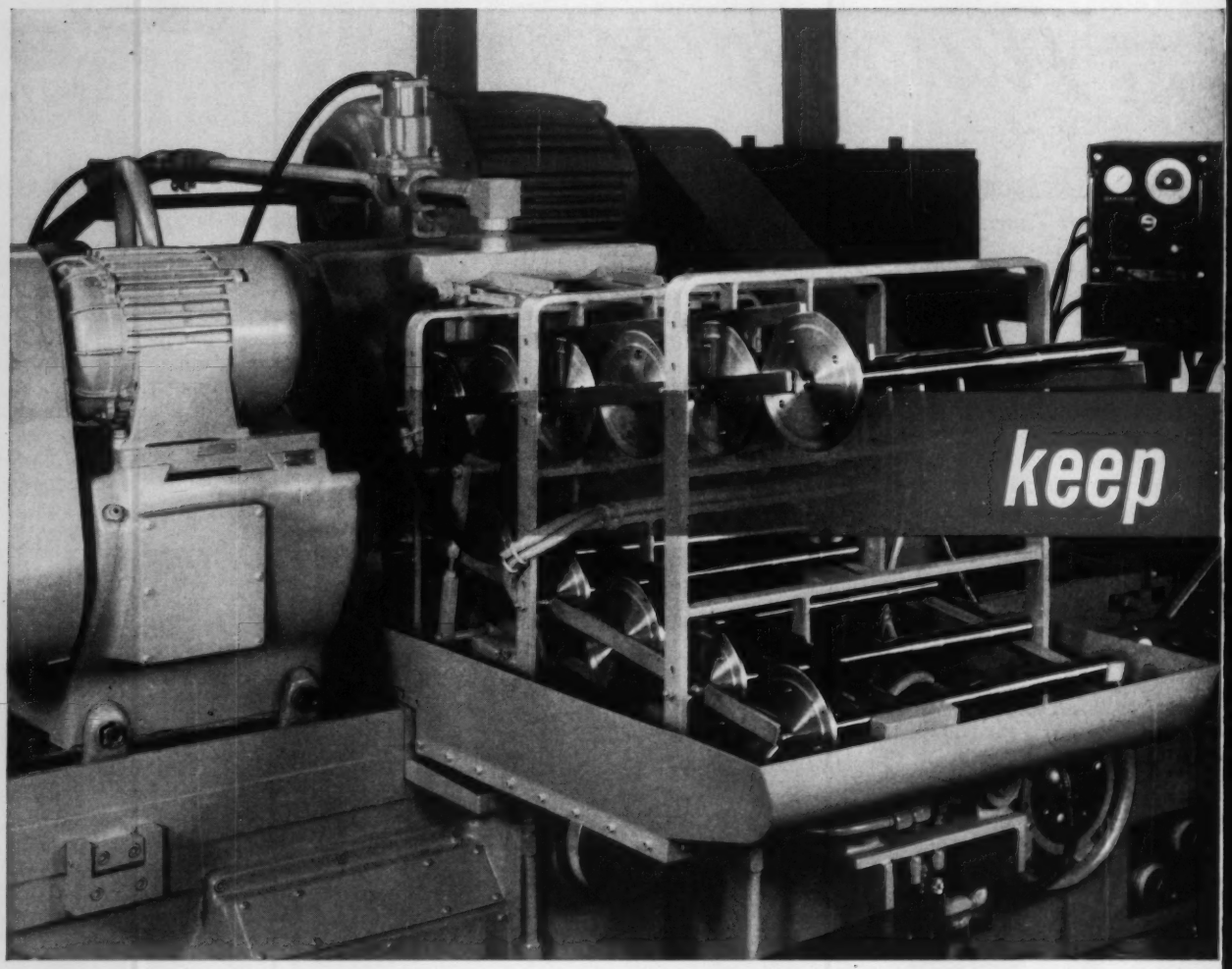
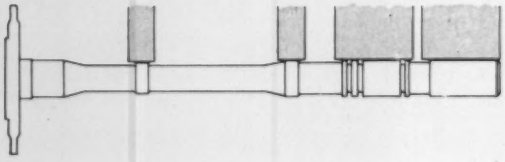


Widely spaced diameters are automatically ground on transmission output shafts. Drawing below indicates ground diameters. Cincinnati Cost-Cutting Specialists equipped a 10" x 36" Plain Hydraulic Grinder for this work. Production: 92 per 48 minute hour.



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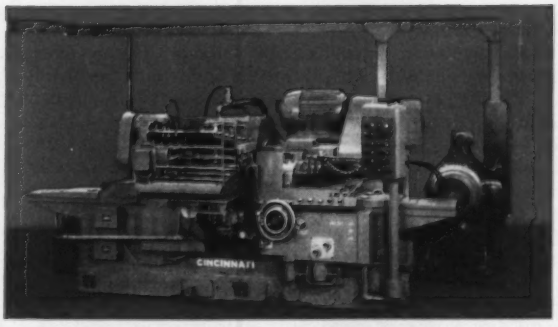
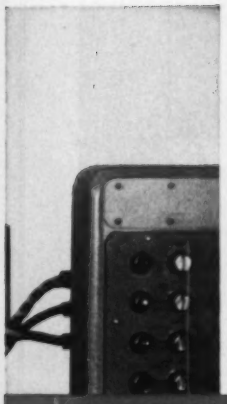
FILMATIC



Completely equipped by Cincinnati Cost-Cutting Specialists for reliable, automatic production. The machine is a CINCINNATI FILMATIC 10" Plain Hydraulic Grinder. Information on standard machines in catalogs G-660-3 and G-661-2.

BUILDERS OF PRECISION GRINDING MACHINES: CENTERTYPE • CENTERLESS • MICRO-CENTRIC

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO



Automatic Centertype Grinders built by

CINCINNATI | GRINDING MACHINE DIVISION

the production line ROLLING!

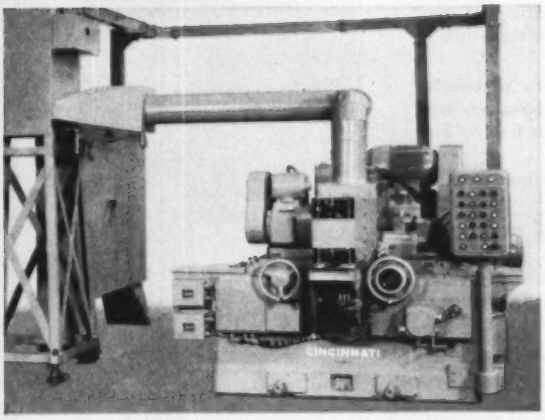
It takes considerable ingenuity to automate centertype grinding machines for continuous production duty. But it can be done quite effectively, as shown by the example illustrated here. The machine is a CINCINNATI FILMATIC 10" x 36" Plain Hydraulic Grinder, one of hundreds engineered and built for various operations by Cincinnati's Grinding Machine Division.

The machine automatically grinds several diameters on transmission output shafts, using multiple wheels having a 16" span.

Production feature-advantages engineered into this machine by Cincinnati Cost-Cutting Specialists include:

- Semi-automatic loading fixtures
- ACRASIZE Gaging System, with "jump on" probing unit
- Hydraulic automatic back rest
- Gap eliminator, to minimize the "grinding air" segment of the automatic infeed cycle
- Automatic wheel truing, including rapid traverse between wheels

FILMATIC grinding wheel spindle bearings and other standard feature-advantages contribute importantly to the extra reliable performance of Cincinnati cost-engineered Grinding Machines. Engineering service second to none; the industry's widest selection of precision grinding machines; our own ACRASIZE Gaging Systems; Cimcool cutting fluids and grinding wheels; these and 40 years' experience in precision grinding are your assurance of the most reliable cost-cutting equipment available anywhere. May we help in solving your manufacturing engineering problems in the areas of precision grinding?



Exhaust to eliminate cutting fluid mist is one type of equipment included with this CINCINNATI FILMATIC 6" x 18" Plain Hydraulic Grinding Machine equipped for automatic production.

• ROLL • CHUCKING • CENTERLESS LAPPING

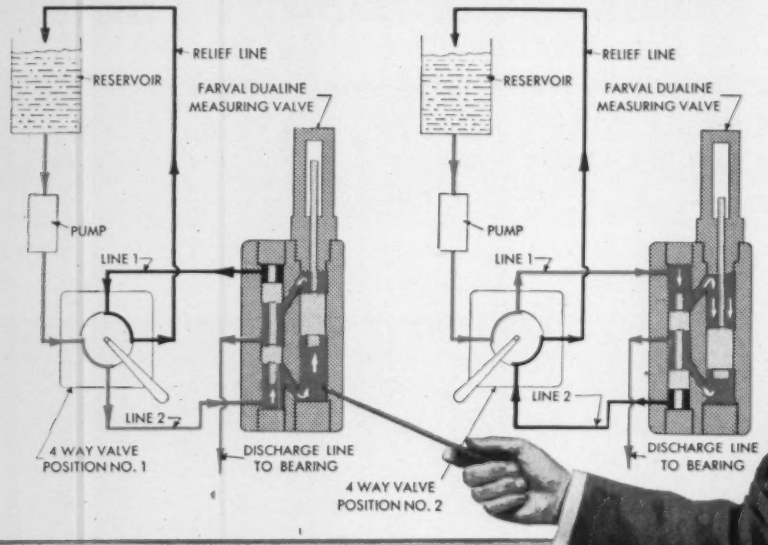
CINCINNATI®
GRINDING MACHINE DIVISION

Circle 657 on Page 35

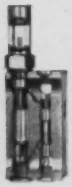
FARVAL
—Studies in Centralized Lubrication
No. 246

"For positive lubrication of large, medium and heavy-duty installations . . . it's a Farval Dualine System!"

FARVAL DUALINE SYSTEMS USE SIMPLE HYDRAULIC PRINCIPLES



With Farval Dualine centralized lubricating systems you get the following distinct advantages over other type systems . . .



(a) Much lower operating pressures with consequently less danger of soap separation on grease systems. Also, less danger of system damage due to high lubricant pressures.

(b) Large lubricant passages with no pinhole ports, ensures practically full pump pressure for every metering valve. This is one of the reasons why Farval Dualine systems operate on lower pressures — give less sieving and working of lubricants.

(c) Positive indication at each bearing — does not have to depend on the questionable action of a single indicator at the pump.

(d) Each metering valve individually adjustable for the requirements of the bearing it serves.

(e) Independent metering valve operation. Should trouble develop with one valve, the system will continue to operate. Only one bearing (not all the bearings) will require hand lubrication until trouble is corrected.

(f) True lubricant metering. Quantity of lubricant delivered to one bearing is not dependent on any other valve in the system.

(g) Much easier to spot and correct trouble.

Check with your Farval Representative and see how these versatile systems can improve production operations — reduce costs. Or write for free Bulletin 26-T containing complete engineering information on Farval Dualine systems.

Farval Division
Eaton Manufacturing Company
3265 East 80th Street • Cleveland 4, Ohio

Circle 658 on Page 35

AUTOMATION news

Today's events and developments in the field of automation

Stock Exchange To Answer Queries Automatically

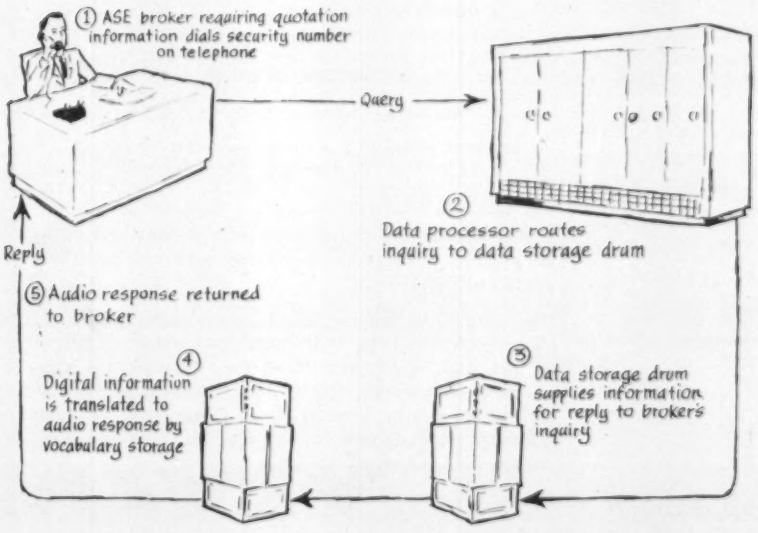
STEP FORWARD through automation was taken by the American Stock Exchange, with the purchase of a new communications facility and data processor. According to **Edward T. McCormick**, president of ASE, the equipment will provide investors with a complete, electronically-automated quotation network that has a combination voice and print-out reporting technique. The system consists of a data processor, memory drum, automatic dialing equipment, and central control machinery which has various subsystems.

Automatic electronic reports will be given of figures on open-high-low-last-bid and asked, volume-to-the-moment, and size (number of shares bid for and number of shares offered), as compared to the present bid and asked, last price procedure. The system has a capacity for reporting on 2000 securities at the rate of 72,000 inquiries per hour via telephone or print-out units. At the present time, 750 member subscribers will be able to query the system concerning the nearly 1100 issues now on the ASE list and not hear a busy signal. The subscribers will dial a security code and telephone lines will signal the data processor to query the memory drum. In two seconds the response will be made with the electronic signals translated into English in a vocabulary storage unit and instantaneously relayed to the subscriber.

Method of information storage begins with the sale and quote figures being fed by pneumatic tubes to the central nerve center. There sales will be ticker-transmitted and sale and quote signals will be loaded in the solid state data processor and stored in the magnetic memory drum. Upon entry into final storage, the quotes, automatically timed, will print out at trading posts for stock specialist verification. Sales figures, when entered, will up-date range and volume data. The equipment will not accept sales outside bid-asked figures, but will print out the entry at a supervisory position for necessary action, giving the Exchange complete control as to the accuracy of the information in the system.

Vocabulary of the voice reproduction unit includes the complete alphabet, the numbers 0 through nine, and the words: bid, offer, last, open, high, low, volume, eleven, thirteen, fifteen, sixteenth, eighth, quarter, half, none, and, active.

This new system was designed as a result of a co-operative investigation between the ASE and Teleregister Corp., who will produce the electronic equipment.


① ASE broker requiring quotation information dials security number on telephone
Query
② Data processor routes inquiry to data storage drum
Reply
⑤ Audio response returned to broker
④ Digital information is translated to audio response by vocabulary storage
③ Data storage drum supplies information for reply to broker's inquiry

Telephones Switched Using Photographic Memory

ELECTRONIC TELEPHONE central office incorporating a shift in switching system design concept has been installed on an experimental basis in Morris, Ill. It is the first system which performs electronically all the functions in the handling of telephone calls and uses a versatile high-speed photographic memory system instead of switch and relay circuits to direct the switching actions. This marks a new era not only in telephone communications, but a significant turning point in the art of telephone manufacture, according to **A. P. Lancaster**, vice president of manufacturing operations at Western Electric Co., builders of the equipment.

Previous means of connecting telephone calls have been by plugs, switches, and relays that are electromechanical in principle and wired in relatively permanent memory and logic circuit configurations. With the new method, calls will be switched by high speed devices

that have no moving parts in the conventional sense, and the switching action will be based on answers stored in the photographic memory. This memory has a capacity of 2¼ million bits of information.

Through the use of neon gas switching tubes, the vast memory system, special electron tubes, and solid state devices which operate in millionths of a second, trial users in Morris can:

- Use home extension phones as intercoms.
- Reach frequently-called numbers by dialing only two digits.
- Have incoming calls routed to another phone when the line is busy.
- Dial a code which automatically transfers incoming calls to another number.

In the electronic central office system which is designated ECO, scanners check each line ten times a second to detect the picking up of phones from their hooks, and barrier grid tubes record dialed numbers and other information regarding calls. The barrier grid

Fifth Conference on Manufacturing Automation

Monday, Tuesday, and Wednesday

April 17, 18, and 19, 1961

Purdue University, Lafayette, Indiana

CONFERENCE TOPICS AND SPEAKERS

Plans and Policies for Automation

DR. JOHN G. HUTTON, General Manager, Specialty Control Dept., General Electric Co.

Comprehensive Analysis of an Automation Project

Shall We Automate?
E. H. GRUMICH, Chief Engineer, Parker Pen Co.

Preparation of the Proposal
C. C. HOLLOWAY, President, Gilman Engineering & Mfg. Co.

Design of the Automated Machine
LYELL C. TULLIS, Chief Engineer, Gilman Engineering & Mfg. Co.

Co-ordinating Research, Engineering, and Production Talents for Development of Integrated Equipment

JOHN R. WILSON Jr., Supt. Production Engineering, AC Spark Plug Div., General Motors Corp.

A Look at Investment and Payback

S. B. KORIN, Corporate Manufacturing Research, International Business Machines Corp.

Management Aspects of Numerical Control

H. O. OLESTEN, Supervisor Numerical Controls, Rohr Aircraft Co.

Automatic Finishing Operations

WALLACE HERDLEIN, Exec. Vice President & Manager, Industrial Div., R. C. Mahon Co.

Automated Production of Transistors

FRED E. STOTE, Mgr., Division Mfg. Services, Texas Instruments Inc.

Continuous Filament and Web Processes

LLOYD W. MYERS, Assistant Supt. Manufacturing Engineering, Omaha Works, Western Electric Co.

Transferring Methods

M. CALVIN IRISH, Chief Product Engineer, National Automatic Tool Co.

Balancing Production Lines by Banking and Storage Between Operations

J. P. TEAS, Technical Director, Flood Co.

Tricks in Handling Paper Products

J. R. HUMPHREY, General Manager, Humphrey Design & Mfg. Inc.

Developing Controls for Automated Equipment on a Systems Basis

H. R. CHOPE, Exec. Vice President, Industrial Nucleonics Corp.

Monitoring, Logging, and Control with Data

A. A. HIGHLAND, Industrial Product Planner, Computer Dept., General Electric Co.
W. F. WILLIAMS, Senior Systems Analyst, Computer Dept., General Electric Co.

Systems to Control Time Cycles

VINCENT C. BLECKER, Manager Industrial Sales Div., Eagle Signal Co.

LUNCHEON SPEAKERS

Automatic Disassembly—Meat Packers' Problems

B. T. HENSGEN, Associate Director, Engineering Research Dept., Swift & Co.

Ingenuity and Engineering—Unusual Problem Parts Feeders

FLOYD SMITH, President, Automation Devices Inc.

Bottled in Bond—Automating the Distillery

E. A. McKENNA, Chief Industrial Engineer, Schenley Industries Inc.

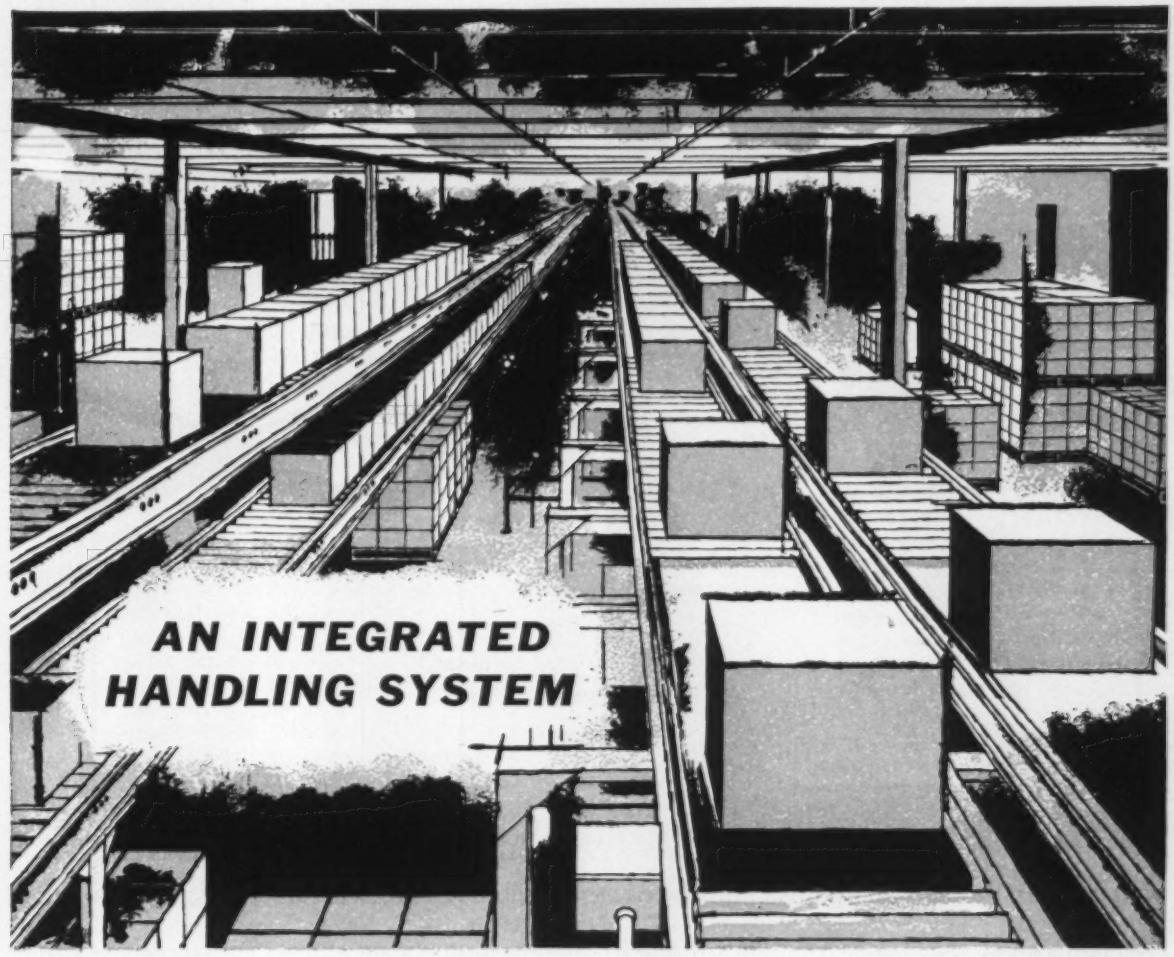
BANQUET SPEAKER

Coming: Automatic Controls' Greatest Era

GEORGE M. MUSCHAMP, Vice President Engineering, Industrial Products Group, Minneapolis-Honeywell Regulator Co.

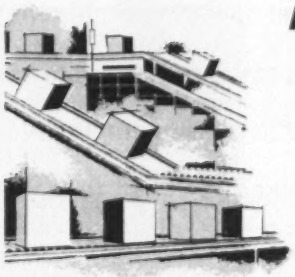
Off-the-record discussion groups are included in the conference schedule to assist all attendees in exchanging thoughts on problems and experiences and conversing with the speakers in small groups.

The Fifth Conference on Manufacturing Automation is co-sponsored by the Dept. of Industrial Engineering and School of Mechanical Engineering of Purdue University, the Manufacturing Engineering Council, and AUTOMATION. For additional information contact: K. E. Glancy, Div. of Adult Education, Purdue University, Lafayette, Ind.; or AUTOMATION, Penton Bldg., Cleveland 13, Ohio.



Overhead conveyor system saves thousands of square feet of floor space.

...Engineered by ALVEY...



May Cut Your Package Handling Costs

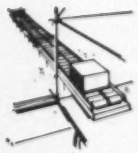
It doesn't pay to buy conveyors piecemeal. You don't have to throw away your present equipment and start from scratch, either.

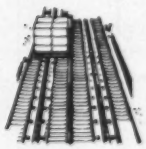
Alvey's experienced package handling engineers can show you how to coordinate the workable parts of your present system with new elements for faster, easier, less expensive materials handling.

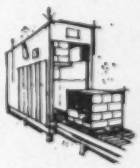
Or, they can build a complete system for a new plant, or total modernization program.

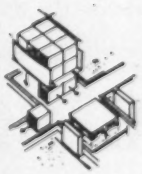
Remember, it's often more profitable to cut processing and handling costs than to make new sales. Call in Alvey, and reappraise your handling methods now.

Vertical Lift Conveyors

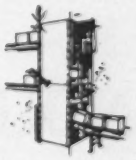

Telescopic Boom Conveyors


Air-Chain Conveyors


Pallet Loaders


De-Palletizers

Traffic Cop


Vertical Indexing Conveyors

ALVEY CONVEYOR MANUFACTURING COMPANY

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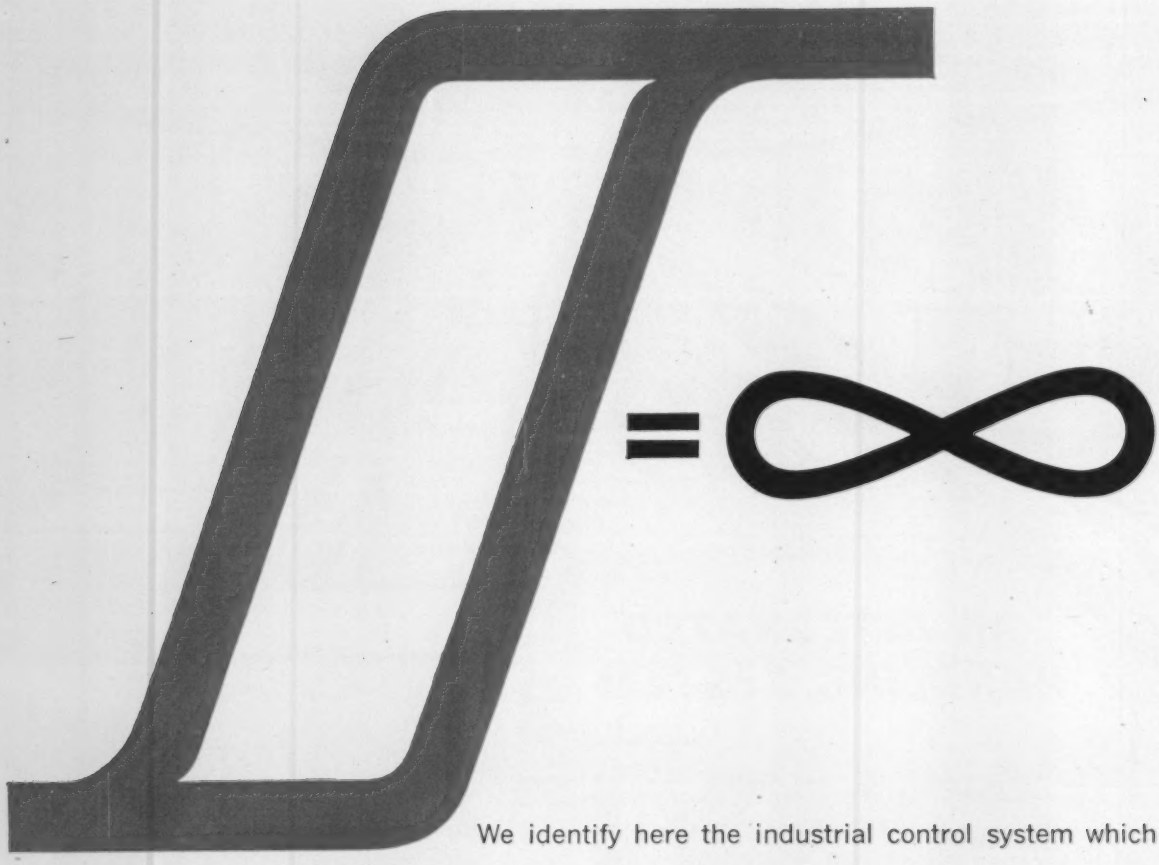

We identify here the industrial control system which will operate through an endless number of cycles without need for human direction, maintenance or servicing. The symbol for infinity in the equation shown above is obvious. The other symbol, the hysteresis loop ⫽ defines the system as *magnetic* static control. The word "static" is used because there are no moving parts. Thus, under normal operating conditions the system never wears out. Customers have come to us for magnetic static control systems which are in use today from the automated lines of New England textile mills to automobile assembly lines in Detroit, to the steel mills of the Argentine. If you, like they, wish to learn what operational statistics and costs *could* be by using magnetic static control for long life and dependability, will you please write us? Magnetics Inc., Dept. A-83, Butler, Pennsylvania.

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INDUSTRIAL CONTROL EQUIPMENT

MAGNETICS inc.®

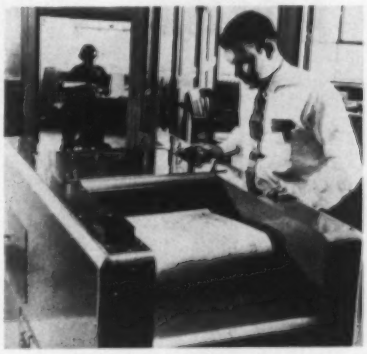
tubes are special electron tubes in which a charge or lack of charge at any particular place on a mica target represents a bit of information. Charges are placed on the mica by a beam of electrons. The common control has a photographic memory called a flying spot store which instructs the switching system at every stage in the completion of a phone call. The central control logic co-ordinates the other units and directs the signal distributor and network markers to set up the proper connections between telephone callers. Functions of these components are accomplished by dozens of high-speed elementary actions that take place a thousand times more quickly than in present dial telephone systems.

Although the system at Morris is an experimental version, engineers at Bell Laboratories are already at work on a production model, suitable for volume manufacture by Western Electric Co. Many components in the production model will differ from those used at Morris, but the over-all philosophy will be similar. The first production model will be operating by mid-1965, and from that time on, the ECO system will gradually be introduced into the Bell System to meet the needs of telephone growth and to replace worn-out central offices.

Signal Energy Density Analyzed

DIGITAL vibration analyzer in production at Communications Control Corp. performs on-line spectral density analysis of random or periodic signals. Strain, vibrations, pressure fluctuations, voice and communications signals are handled. The system, designated Vibracoder, performs an energy distribution over a bandwidth of 5000 cps with a resolution of 50 cps. The distributed energy is then encoded at a rate of 5000 readings per second, placed on ½-inch magnetic tape in compatible form for direct entry to International Business Machines Corp. equipment.

The encoded data represents the energy spectral density over the 5000 cps bandwidth accurate to better than 1 per cent. The entire spectrum is swept and encoded every 20 ms or on command. The tape can then reproduce the energy spectrum, second by second, in tabulated or plotted form or for processing through computing equipment.



DOCUMENT retrieving system prints over a square foot of information per second as received from a distant sending unit. A 480-page book can be sent from New York to Los Angeles in a matter of 4 minutes. Information such as engineering drawings or other documents stored on microfilm in a central file can be transmitted via coaxial cable or microwave transmission network to the multiple stylus continuous facsimile recorder. Full-size copies are immediately reproduced on electronic recording paper. Hogan Faximile Div., Telautograph Corp., sold this prototype to the U. S. Navy. Compact versions suitable for industrial and commercial uses will be available on a lease basis.

Computer Rental Plans Made More Flexible

COMPUTER RENTAL system, tailored for individual data processing needs, has been introduced by Radio Corporation of America. The new plan offers four different rental agreements instead of the previous single rental-plus-overtime charging system. It will apply to the new RCA 301 and 601 systems which will go into use this year, as well as the 501 medium-scale data processing system. The lease arrangements set basic monthly charges for different combinations of work requirements, resulting in a decrease in cost per unit, as the work load increases, according to **Donald H. Kunsman**, vice president and general manager of the Electronic Data Processing Div.

The four rental plans are designated as:

- Unlimited availability — which provides for operation of the equipment seven days a week, with a basic monthly charge of 30 per cent over the single shift rental.
- Extended availability — provides for operation up to 24 hours a day, five days a week, with a charge of 20 per cent over the single shift rental.
- Random use—entitles the customer to a maximum of 200 hours, at his option, in each calendar month at a basic charge of 3 per cent over the single shift rental.
- Single shift availability — a standard rental, covering a primary shift of eight consecutive hours per day, five consecutive days a week, designated at the customer's option.

"Under the unlimited availability plan," Mr. Kunsman said, "a customer could obtain 200 per cent more time than under the current single shift agreement at a cost increase of only 30 per cent."

DEFLECTION COMPENSATION has been built into a 100-ton hydraulic C-frame press by Rucker Co. for an application in the com-

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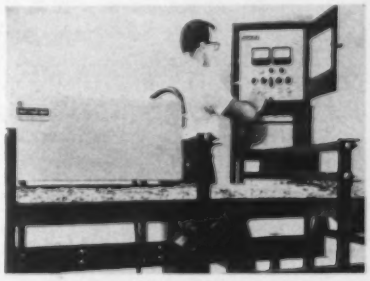
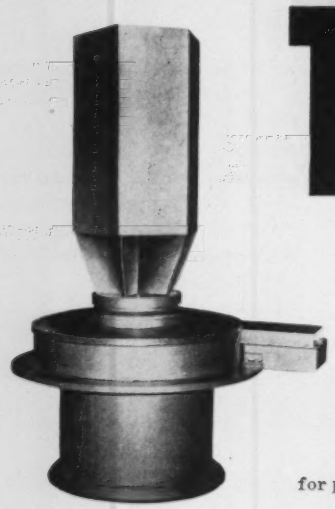


PERCENT MOISTURE GAGE, developed by Nuclear-Chicago Corp., measures and records the percent moisture by weight of solid materials. In the illustration, the measuring head is located directly over material on a conveyor belt. A scraper bar, at the right, rough-levels the material on the conveyor before it is measured. The electronic rack and recorder/controller can be located at a distance from the measuring head, which is also available as a long cylindrical probe that may be inserted directly into the contents of a bin or hopper.

THINK WHAT YOU, TOO, COULD DO WITH A VERSI-TABLE TOOL TREE



THE VERSI-TABLE TOOL TREE grows out of an advanced concept of synchronous multiple machining operations based on unrestricted rotary indexing. Work units of your own determination branch out from the upright steel trunk, with the Versi-Table index set to as many work stations as required. Design and dimension of the Versi-Table Tool Tree conforms, in each instance, to the particular job specifications, with full latitude allowed for almost unlimited diversification. Positive precision indexing is accurately adjusted to each fixture, and the automated work flow is without flaw or hindrance. A matter of special appreciation is the round-the-trunk accessibility so conveniently provided by the Versi-Table Tool Tree. Let Savage Engineers confer with you on what you would like to accomplish with this low-cost method of multiple machining sequence, — the outcome may well be what you need for eliminating a production bottleneck, for increasing production, for lowering production cost, and for placing your business in a more favored position. What Savage Engineering is doing for others, it can also do for you,—and no obligation is attached to finding out.

VERSI-TABLE

CAN DO THINGS NO OTHER MECHANICAL ROTARY INDEXING METHOD CAN DO!

A whole new range of rotary indexing applications — with increased efficiencies never before possible — is opened up to you by Versi-Table and its Vari-Fine adjustment. The functions of rotary indexing are multiplied because the arbitrary limitations are no longer present.

In short, Versi-Table does things no other mechanical rotary indexing method can do.

You can set Versi-Table on odd and/or even spacing, thereby having all the stations on the full circle of the table at your disposal. You can make the settings, and change them as much as you please for all your various jobs.

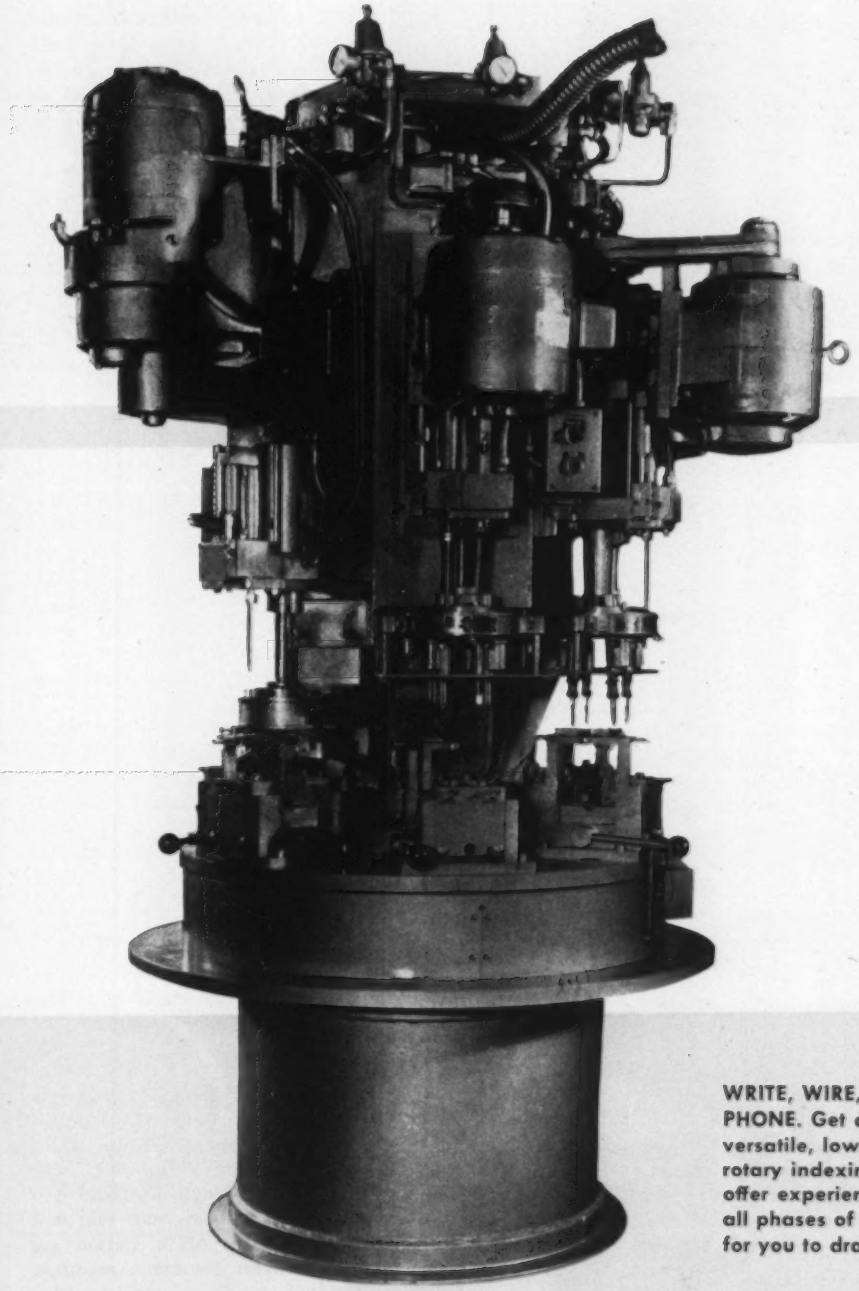
You can adjust the index to the fixture instead of having to make the fixture conform to the index for accuracy. On each of the selected stations you have from 0 to 15° to obtain precise indexing position.

You can obtain your own measure of precision through the Vari-Fine adjuster — quickly, conveniently, and accurately. By the same means you can also adjust out any deviation that occurs through wear.

You are sure of a positive stop on each station, with cushioned control on the positioning end of the index.

You can work to variable indexing speeds.

These, and other, exclusive features spell out for you a versatility that can be translated into new efficiencies and cost savings such as greatly improve your production profit. Versi-Table, either as an individual unit or incorporated in a TOOL TREE, may be specified to the size required, either air or hydraulically operated. Full details and engineering consultation gladly — and freely — given. Inquire, now, — take steps, now, to find out how Versi-Table can do more for you than any other mechanical rotary indexing method.



THERE IS NO END TO VERSI-TABLE USEFULNESS THROUGH ITS UNLIMITED VERSATILITY

A rough valve casting, manually loaded and unloaded, receives a finished facing, 2 step bores, micro set for depth, 4 spindle drillings, 4 spindle tappings, a 2-step ream, and a thorough broach, coming out a fully finished, machined piece, — and all 14 operations done in 18 seconds from in and out. What's your problem? Let a Versi-Table Tool Tree solve it for you, — engineered to your own specific needs.

WRITE, WIRE, or better yet, PHONE. Get detailed data on versatile, low-cost Versi-Table rotary indexing. Savage Engineers offer experienced skills in all phases of automation for you to draw upon.

THE LITHIBAR COMPANY

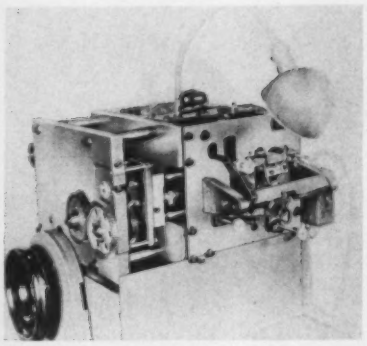
HOLLAND, MICHIGAN, U.S.A.

SAVAGE ENGINEERING DIVISION

Telephone EXport 6-5215

Circle 660 on Page 35

pressing of beryllia. Because of critical deflection limits, the press was designed to meet requirements of less than 0.020-inch spread of the C at 100 tons force. This was accomplished by locating hydraulic counteracting cylinders at the back of the C to compensate for the pressing tonnage. The reaction or compensating load is in continuous direct relation to the pressing load. Operation of the press is fully automatic, with a manual override for each function. It will maintain a predetermined pressure, with the platens closely synchronized during a major portion of the pressure cycle by means of servo controls.

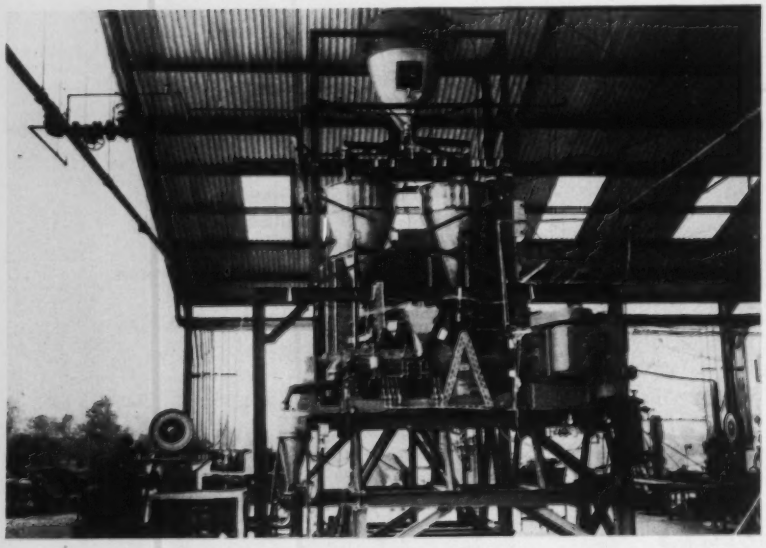


SPRING MAKING MACHINE produces an entire spring with formed end loops in one cycle. Unit developed by Baird Machine Co. combines operations formerly performed by two separate machines—forming the coil from wire and making loops on opposite ends of the coil. Production rate is 720 to 6400 pieces per hour for different types of springs, different end loops, and feed lengths up to 26 inches in the 0.008—0.034 inch wire range.

Electronic Circuit Concept Adaptable To Automation

AUTOMATED production methods, applied to thin film techniques, will improve precision and reliability of electronic circuit components, according to **Lewis W. Imm**, president of Intellux Inc.

Through the use of thin film techniques, which promise reduced size, weight, and cost, electronic circuits can be condensed to a density of up to 2,000,000 components in a cubic foot of space. Imm stated that such techniques have already provided a 50 per cent reduction in soldered joints, one of the highest cost factors in conventional circuit production, and one of the most troublesome reliability areas. Future developments are expected to reduce this figure to less than 2 per cent of the connections required in standard circuits. Expected applications for thin film components and modules include use in logic and memory circuits for computers and machine controls.



CONTINUOUS MIXING process for producing solid propellant fuel for the Polaris missile, is based on a machine manufactured by the Chemical Machinery Div., Baker Perkins Inc., and used by Aerojet-General Corp. The machine shifts propellant compounding from a slow, stop-and-go batch procedure, to a closely-controlled, continuous flow operation and steps up volume of output in a ratio of nearly 3:1 over the previous method. A continuous stream of carefully metered propellant ingredients is collected from several sources and processed through a chamber in which an interrupted screw mixes them continuously into a high-energy rocket fuel. Leaving the mixer, the paste-like propellant passes four stream analyzers before it is moved to the casting area where it is placed in rocket casings. Quality can be closely controlled through the continuous testing, and safety is increased since only 20 to 25 pounds of propellant are in process as contrasted to 2200 pounds in the batch method.

Packaging Institute Inc. Names New Officials

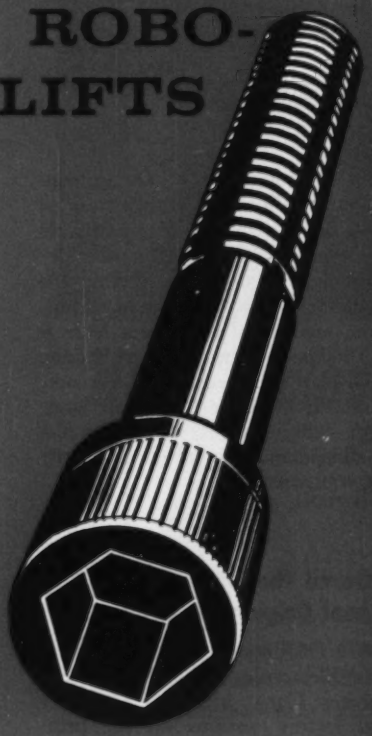
DURING the recent National Packaging Forum in New York City, new officers were elected for the Packaging Institute Inc. Serving as president for the coming year will be **Lawrence H. Zahn**, director, Purchasing and Package Development Div., CIBA Pharmaceutical Products Inc. **Fred W. Langner**, package coordinator, Socony Mobil Oil Co. was elected vice president and treasurer; **Allyn C. Beardsell**, New Products Div., Mead Containers Inc., was elected vice president-membership; and **Iven G. Nichol**, assistant sales manager, Morningstar-Paisley Inc., was elected vice president-Annual Forum. The Packaging Institute is a national technical organization which represents over 400 corporations and 700 professional packaging executives. This includes both users and manufacturers of packaging materials.

ELECTRONIC data logging system is being built by Control Corp., subsidiary, Control Data Corp. for Boston Edison Co. The system will automatically read 140 electric meters every hour and will type the results on a station log sheet. Between automatic readings, individual readings can be displayed on an illuminated screen by pushing a button.

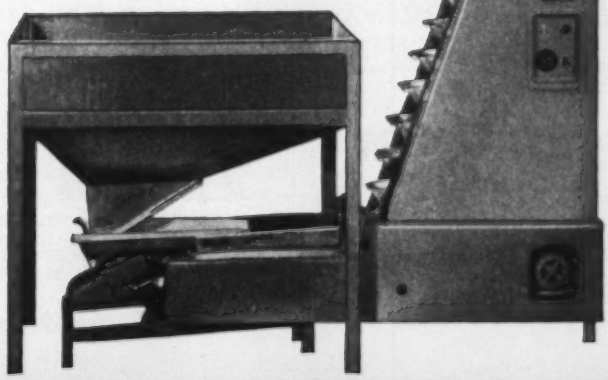
Long-Term Equipment Lease Plan Established

LONG-TERM lease plan for equipment worth as little as $25,000 has been initiated by Nationwide Leasing Co. Under the new plan, companies can lease equipment for terms as long as six to twelve years, if they have a tangible net worth

All 'special' problems; yet all are solved by 30 standard LYNCH ROBO-LIFTS



When otherwise good conveyors cannot handle foods, drugs, hardware, chemicals ... powders, solids, granules in the very very gentle, very very sanitary way required ... with intake and discharge positions wherever required, Leaders Look To **LYNCH ROBO-LIFT.** Call the Lynch engineers. Whether it's handling raw materials, in process materials, or feeding a Robo-Wrap or other packaging machine ... tell us all about your problem. Your most difficult problems are our best opportunities.



30 STANDARD MODELS—CAPACITIES: from 1.0 cfm to 40 cfm; 90 or 70 degree elevating angle; 10, 15, 20, 24 and 30 inch bucket sizes, stainless steel, or mild carbon steel; top and underdumps, height and length to meet any requirement.

ENGINEERING SERVICES: Should your materials handling problem be a troublesome one, send us the details. Perhaps one of our 30 *standard* Robo-Lifts will do the job. Specifications for special enclosures, drives, feeds and discharge arrangements on request.

LEADERS LOOK TO LYNCH—FOR MACHINES THAT PACKAGE ALMOST EVERYTHING!

Manufacturing engineers of automatic processing equipment for the glass, packaging, and other industries.

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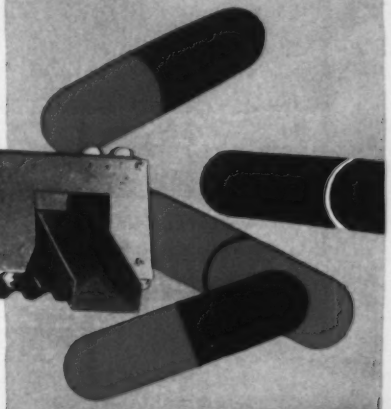

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CORPORATION
Anderson, Indiana, U. S. A.

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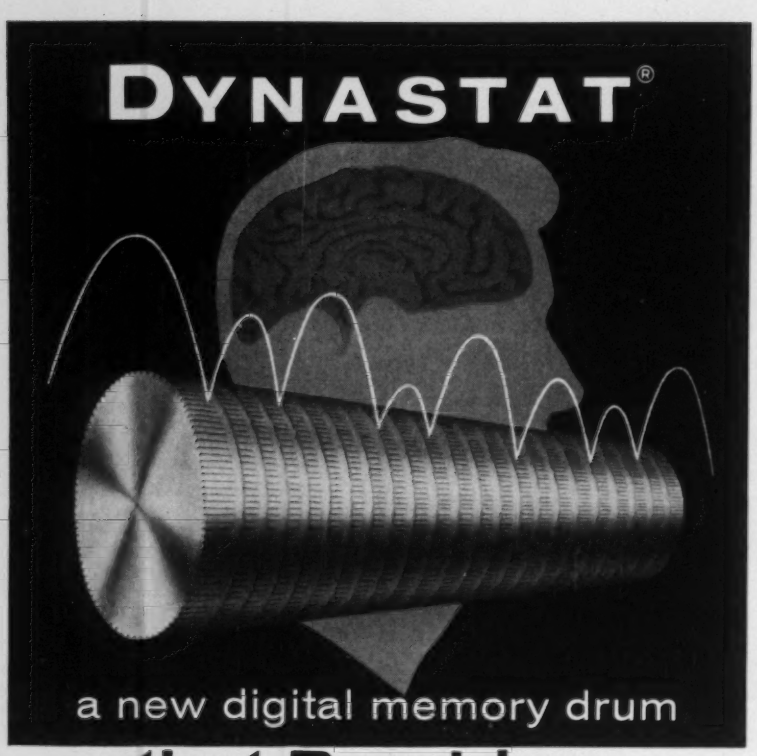
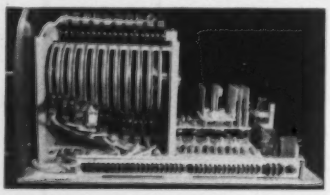
DYNASTAT®



a new digital memory drum

that Provides:

- *INDEPENDENCE OF SPEED (can be read out while standing still)*
- *HIGH LEVEL OUTPUT (no low level signal amplifiers)*
- *CONTINUOUS ACCESS (eliminates buffer storage)*
- *NON-DESTRUCTIVE READOUT (no recirculating delay lines or registers)*



®The DYNASTAT drum operating principle is protected by various patents, both issued and pending.

Here is a digital magnetic memory drum whose read heads respond to flux intensity rather than rate of change of flux.

Because it is independent of rotational speed, the DYNASTAT drum offers new system possibilities in such applications as the programming of machine tools and automation equipment, master control of inspection, counting, conveying, and material handling, and synchronous parallel-to-serial reversible code conversion.

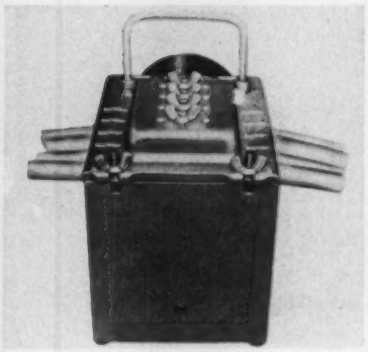
Outstanding reliability stems from the unique bistable action of the read heads which permit a broad tolerance of spacing from the drum surfaces and which offer output levels that eliminate the need for signal amplification.

Many system designs show important economies when the DYNASTAT drum is introduced. Find out how you can profit from the use of DYNASTAT. For complete product information and its application to your need, write or telephone Mr. Charles M. Colt, Pioneer 3-6721, DDD Code 203.

CONSOLIDATED CONTROLS CORPORATION

A Member of The Condec Group

BETHEL, CONNECTICUT
INGLEWOOD, CALIFORNIA



MULTIPURPOSE PUMP, designed by Custom Machine Co., can handle four different fluids or gases at one time with the flow rate of each material controlled separately. It can pump glue, inks, acids, and other liquids at up to 30 gph, and will handle gases at the some volume rate. The pump is designed so the materials are isolated from contact with the pump parts, eliminating cleanup problems when changing over to different liquids or gases.

of 1 million dollars. Other conditions are that the company must show a five-year record of profitable operations and the equipment desired must have a depreciable life greater than the lease term. Minimum amount of equipment lease is $25,000 and there is no maximum. This plan was devised to free companies from the need to tap long-term debt or equity funds for the smaller amounts involved in acquiring equipment.

Infrared Thermometry School Originated

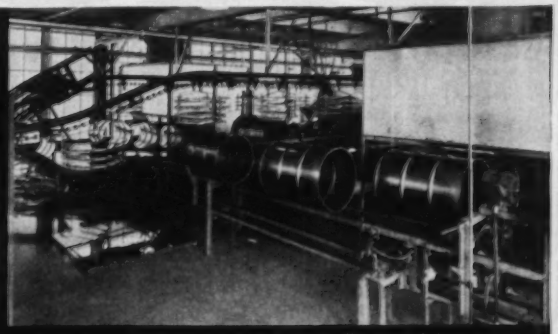
TWO-DAY course offered by Radiation Electronics Co., Div., Comptometer Corp. includes laboratory and lecture sessions on the principles and practices of Infrared Thermometry. The course is conducted by Herbert L. Berman and Dr. Arthur E. Goldberg of Radiation Electronics Co. Topics include: Principles and applications of infrared sources, infrared sensing devices, optical materials, radiation thermometers, and remote temperature measurement and control.

DIGITAL CONVERTER, developed by MacLeod Instrument Corp., can convert the indication of conventional pointer-type instruments for operation of standard digital readout equipment. It is most suitable

Circle 662 on Page 35

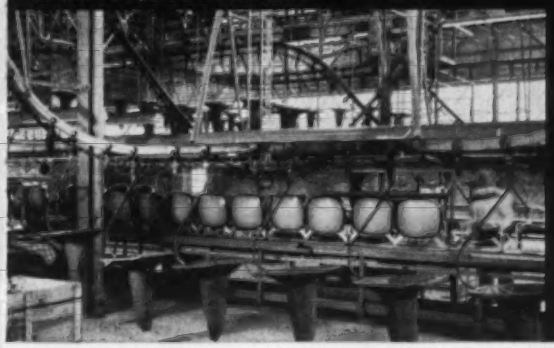
METAL WORKING—PACKAGE HANDLING—DISTRIBUTION—WAREHOUSING

Package handling system for large auto parts distribution center. Photoelectric cells control automatic dispatch system.

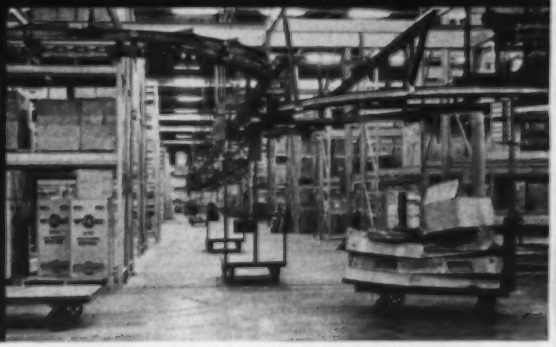


Steel drums and covers are automatically moved into spray booths. Covers are brought from floor below.

A television tube conveyor on a chassis assembly line. Fast efficient flow pattern is maintained.



Overhead pullveyor in large warehouse has 18 different selector stations for automatic transfer of trucks.



Have a closer walk with Total Automation

CSI-*Farquhar's* complete approach to system handling problems can help you regain those lost profits

ASK FOR BROCHURE

A complete 56-page book shows hundreds of applications of trolley, slat, power belt, live roller, spindle and countless other conveyors. Send for your copy today!

MEMBER CMA CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION

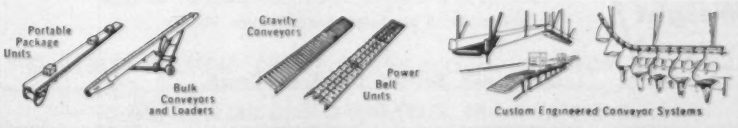
Closer and closer approaches to *total automation* will be the difference between success and failure in heavy competition. Get geared up now! CSI-Farquhar offers you the *complete approach* that never overlooks any possibility for automation where any substantial economy may be gained. This complete approach is born of a successful record in solving the most intricate and difficult conveyor problems for many of America's foremost industrial companies.

If you want to regain lost profits and get automatic system handling in the most modern sense, contact us at CSI-Farquhar. We think we can be of service in your drive toward lower costs.

CONVEYOR SYSTEMS, INC.

6453 Main Street
Morton Grove, Illinois (Chicago Suburb) Phone: JUniper 8-0200

CSI Farquhar CONVEYORS



THE COMPLETE LINE OF CUSTOM AND PRE-ENGINEERED CONVEYING SYSTEMS

Circle 663 on Page 35

EXACT WEIGHT'S New Automatic Checkweigher

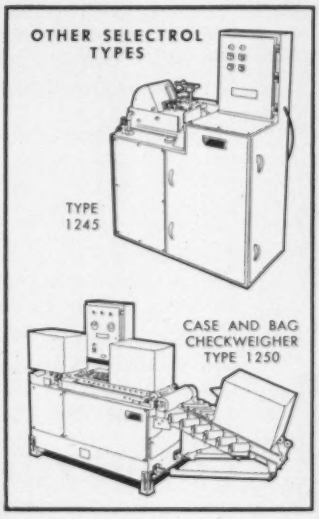
SELECTROL®

MODEL 1206 with horizontal (side by side) rejection for tall products such as cans, cartons, etc.

This new Selectrol checkweigher automatically weighs, classifies and sorts at speeds up to 120 items per minute, depending on size and weight of object. Rejection accuracy is 2/10 of one percent of the weight of the commodity at maximum speed.

New Selectrol features include compact size that requires minimum space in a conveyor line . . . and simplified circuits. Electrical controls are mounted above the conveyor line for easy accessibility.

Selectrols are made by Exact Weight, a leading manufacturer of job-engineered scales for 45 years with experience gained through hundreds of checkweighing installations during the past 18 years. For complete details, write for Bulletin 3377.



Exact Weight SCALES

THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Sales and Service Coast to Coast

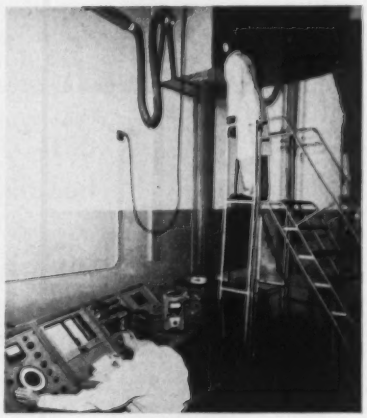
Find us in your local "Yellow Pages"

BETTER QUALITY CONTROL . . . BETTER COST CONTROL

to instruments having circular scales, including pressure gages, temperature indicators, flowmeters, voltmeters and wattmeters. The pickoff unit is photoelectric, and imposes no mechanical load on the measuring instrument.

SPOTLIGHTING PEOPLE

Thomas G. Lanphier Jr. elected president of Fairbanks, Morse & Co. . . . **Duncan N. MacDonald** appointed director of engineering for the ElectroData Div., Burroughs Corp. . . . **Bryce I. MacDonald Jr.** named manager of manufacturing engineering, Silicone Products Dept., General Electric Co. . . . **Hans-Joachim Kunzke** appointed special design engineer for computer and electronic data processing products, Clary Corp. . . . **Robert C. Main** joined Sperry Products Co., Div., Howe Sound Co. as manager of engineering. . . . **Simon Fisher**, president of Nation-



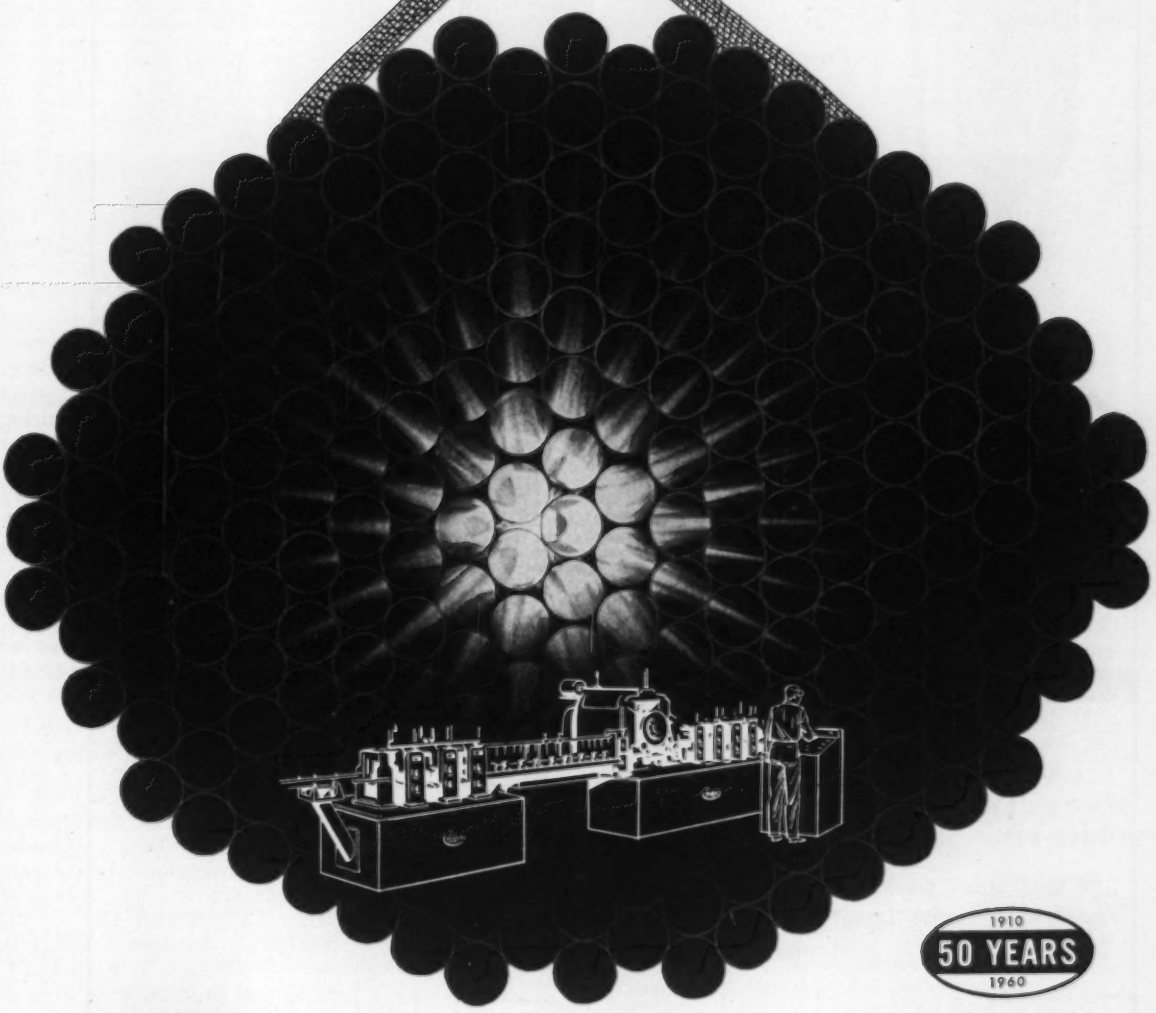
VIBRATIONAL COMPACTION unit resembling a giant hi-fi set is used as a shaker or vibrator for packing nuclear powder materials into fuel elements for atomic reactors at the Atomic Energy Commission's Hanford plant, operated by General Electric Co. Fabricating nuclear fuel elements by this process is actually a flexible method of simultaneously compacting and cladding ceramic fuel materials. Vibrations are generated by a 24,000 watt power amplifier system. Tubes up to eight feet long, which serve as the cladding or jacket for nuclear fuel element materials, are attached to the vibrator, and nuclear fuel powder poured in from the top is compacted to more than 90 per cent of the theoretical density in about three minutes. The loud speaker or vibrator portion of the equipment consists of a moving coil which is alternately attracted and repelled by a large electromagnet to deliver a thrust of up to 5000 lb force.

If you need lots of pipe or tube...

YODER makes the mills that make it!

For complete information on YODER Pipe or Tube Mills . . . write for the fully illustrated, 88 page YODER Tube Mill Book . . . it is yours for the asking.

THE YODER COMPANY
5526 Walworth Avenue • Cleveland 2, Ohio



1910
50 YEARS
1960

ENGINEERING
YODER
MANUFACTURING

PIPE AND TUBE MILLS (ferrous or non-ferrous)

COLD ROLL FORMING MACHINES

ROTARY SLITTING LINES

Circle 665 on Page 35

HANNIFIN *Crown*

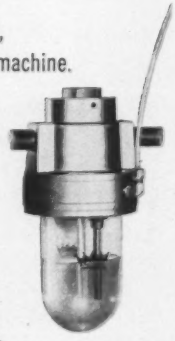
delivers air the way you want it!

With "Crown" remote controlled units, you can filter and drain overhead air lines, control regulators from below, and fill lubricators without climbing.

Or, with our completely standard units . . .

. . . you can provide just the right amount of filtered, regulated and/or lubricated air right at your machine.

NEW! **PULSE-LUBE . . . for off-beat air flow**



If air flow is uphill or light or so infrequent that air-borne lubrication won't solve your problem, you can deliver oil just where you need it, in the exact amount you need, through a tiny flexible tube with new "Crown" Pulse-Lube . . .

All these "Crown" developments are detailed and described in a new, comprehensive "Crown" catalog (our Bulletin 0400-B1). We'll be happy to send you one.

PARKER HANNIFIN CORPORATION

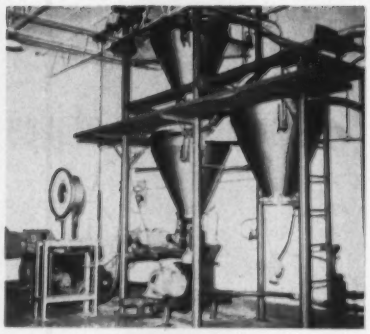
HANNIFIN COMPANY

A DIVISION

541 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

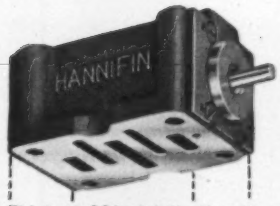
EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS



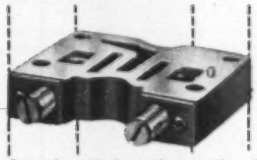
TESTING of air conveying systems is the function of new research laboratory built by Flo-Tronics Inc. Purpose is to allow customers to test and evaluate materials handling problems in chemical, food, milling, and processing industries. Flow characteristics, material-to-air ratios, horsepower requirements, and equipment performance for various materials can be obtained under regular operating conditions. The laboratory consists of an actual working system made up of fluidizing units, rotary airlocks, bag dump, line diverters, scaling equipment, and transistorized, electronic control panels.

al Electric Welding Machines Co., elected president of the Resistance Welder Manufacturers' Association. . . . **V. V. Tivy** named director of engineering at Foxboro Co. . . . **J. H. Berryman** appointed manager, Special Products Dept., Air Reduction Sales Co. . . . **L. C. Diekmann** named director of manufacturing for the consumer products group of Westinghouse Electric Corp. . . . **Harvey E. Rennacker** appointed senior staff engineer for Bendix Computer Div. . . . **D. L. Nettleton** named chief engineer, Electronic Data Processing Div., Radio Corporation of America. . . . **John B. Mandle** promoted to assistant director of operations at Consolidated Systems Corp. . . . **George V. Jordan Jr.** named manager of a newly created Flotronics Div. at Selas Corporation of America. . . . **John W. Thompson** appointed chief of research and product development at Jervis B. Webb Co. . . . **Charles M. Doolittle** promoted to manager of administration for Advanced Systems Development Div. at International Business Machines Corp. . . . **George J. Bagnall** appointed vice president in charge of engineering and manufacturing and **William L. Gibbons** named factory manager, both at Lapointe Machine Tool Co. . . . **Alfred C. Ryan** elected chairman of the board and treasurer and **John K. Rye** elected

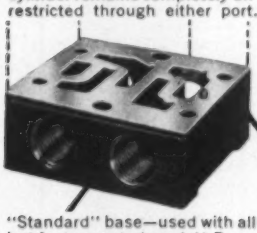
Circle 666 on Page 35



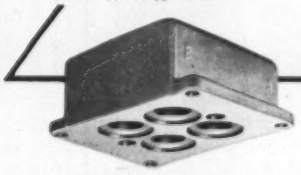
This basic CC body is the "heart" of every CC valve. Its one moving part is the "spool poppet", a Hannifin exclusive that seals bubble tight at either end of its short stroke. Note the ample air passages—all ¼" IPS or larger. This is single-actuator, spring return version.



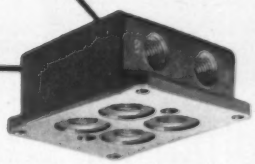
Speed control section, optional—designed to restrict exhaust flow, only, through either or both cylinder ports. Flow to the cylinder remains completely unrestricted through either port.



"Standard" base—used with all but foot-operated models. Every CC base is available tapped either ¼" or ⅜" IPS.



Optional base for "O" ring gasket mounting. Supplied complete with 4 O-rings.



"Universal" base, tapped from beneath and from both sides. Four pipe plugs supplied. Can also be used with O-rings.

This is the same body with double-end "spool poppet"—used when two actuators are required.

For foot-operated valves, the actuator is also the base, and this rear-ported adapter is used. Available tapped either ¼" or ⅜" IPS.

THESE QUICK-RESPONSE 4-WAY VALVES MOVE AIR DOWN THE LINE—FAST!

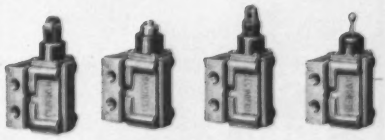
Hannifin CC valve design is the reason. Short, positive strokes of the "spool poppet" open up instant and ample passages for air.

Actuation? Any way you want it!

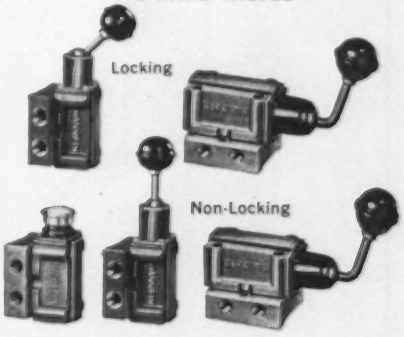
One basic body with a wide selection of operating heads and bases—all with or without our new speed control section—give you over 3,000 choices. We can help you make the right choice . . . through our field engineering service. Call your nearest Parker-Hannifin office or write us direct for full information.

SINGLE ACTUATORS

(Spring Return)



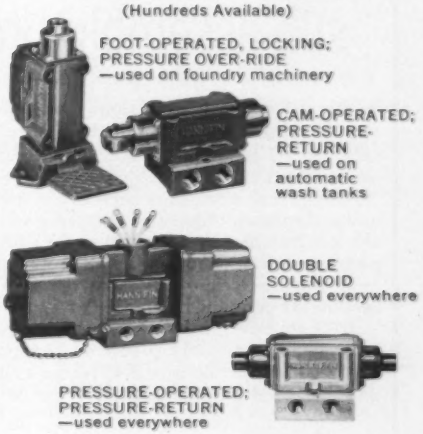
FIVE HAND VALVES



TWO FOOT VALVES

TYPICAL COMBINATIONS

(Hundreds Available)


FOOT-OPERATED, LOCKING; PRESSURE OVER-RIDE —used on foundry machinery
CAM-OPERATED; PRESSURE-RETURN —used on automatic wash tanks
DOUBLE SOLENOID —used everywhere
PRESSURE-OPERATED; PRESSURE-RETURN —used everywhere

PARKER HANNIFIN CORPORATION

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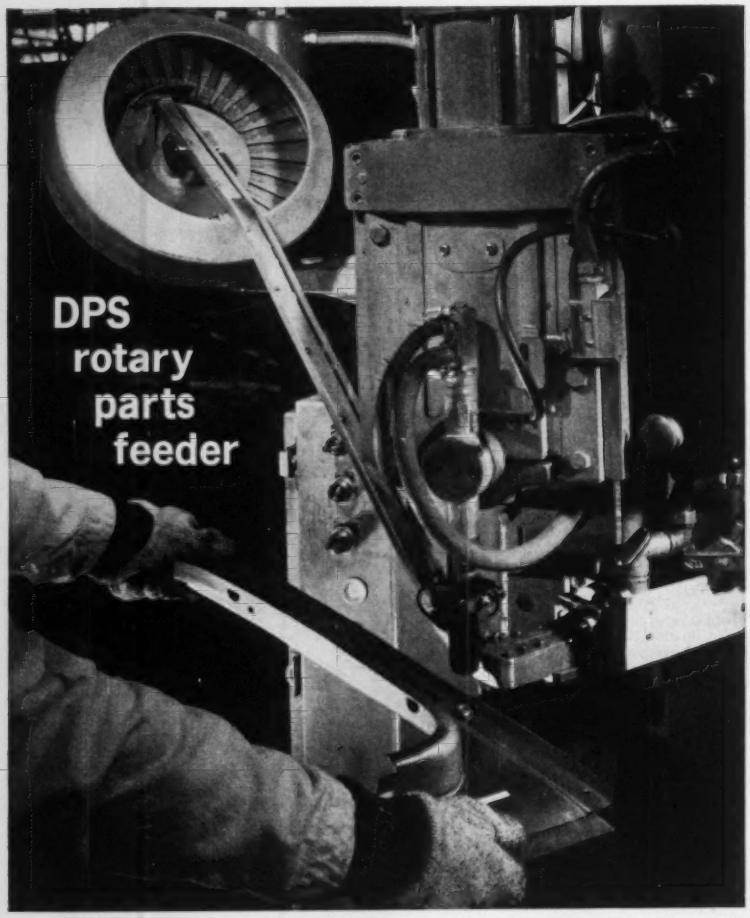
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3138 PH.

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

Circle 667 on Page 35



doubles nut welding output in sub-assembly production line

In this sub-assembly operation, production of the welding equipment was limited because the weld nuts had to be hand positioned. When the DPS rotary parts feeder took over the feeding operation, nut welder output was doubled.

Savings and efficiencies such as this are being effected in assembly operations throughout industry. Parts of a variety of sizes, shapes and materials are successfully being handled in DPS rotary, vibratory and elevating type parts feeders . . . industry's most complete line. Parts ranging from common bolts, nuts and screws to the many more unusual pieces that are used in the complex machinery of today.

DPS engineers welcome the opportunity to work with your engineers in analyzing assembly problems and production line procedures. They will recommend the one best feeder to effect lower manufacturing costs and improved product quality. Write or call today. Ask for free catalog.

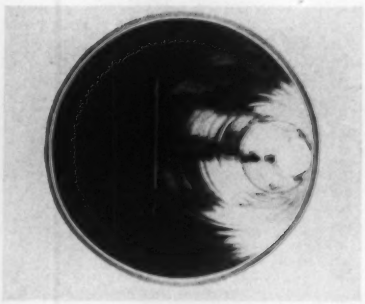
15,602

DETROIT POWER SCREWDRIVER CO.

A Subsidiary of Link-Belt Company

Selective Parts Feeders; Screw, Nut and Stud Driving Machines; Special Purpose Assembly Machines

2811 W. Fort Street
Detroit 16, Michigan
TAshmoo 5-3070



BIMETALLIC pipe, manufactured by Gray Tool Co., has a seamless, corrosion resistant lining hydraulically expanded into the base pipe, forming the lining tightly against the inside of the base pipe material. Additional pressure expands the base pipe, and on return to normal operating pressure, the lining is firmly held against the base pipe due to differential contraction. Linings most frequently furnished are monel, nickel, and stainless steel, but alloys of copper and nickel, as well as reactive metals, can be applied.

president, both at F. Jos. Lamb Co. . . . **Robert D. Schmidt** promoted to director of engineering at Telemeter Magnetics Inc. . . . **Robert M. Gordon** elected executive vice-president of Milford Rivet & Machine Co. . . . **William J. Fath** promoted to director of manufacturing of H-P-M Div., Koehring Co. . . . **Elwood F. Knapp** named vice president of manufacturing and a member of the board of directors at Firewel Co. Inc. . . . **Aaron Blaustein** appointed chief research and development engineer of a newly established Research and Development Dept. at DeJur-Amsco Corp. . . . **Hamilton M. Ross** elected vice president of Hewitt-Robins Inc. . . . **Wes A. Spomer** appointed production manager and **Russell F. Carr** named production control manager, both at Babcock Relays Inc. . . . **Ernest L. Ward** elected president of Sprague Electric Co. . . . **Charles S. Hazard** joined American Machine & Foundry Co. as manufacturing specialist. . . . **Raymond G. Nordstrom** appointed executive vice president, Hevi-Duty Electric Co. . . . **Martin Rubin** named senior staff engineer of Data Systems Laboratory at Litton Systems Inc. . . . **Robert J. C. Damon** elected executive vice president and chief executive officer of Bowser Inc. . . . **K. N. Krecke** appointed manufacturing manager for Ford Motor Co. stamping plants. . . . **William F.**

Circle 668 on Page 35

UPPER LEFT . . . Loaded train moves through doors that have automatically opened, and commences trip over 1400 feet of Monorail track.

Louden Monorail Interplant Transport System operates trouble free the year around. Three carriers make up train that travels completely unattended from storage area in one building to shipping area in another. Smooth operation of Monorail insures safe transportation of chinaware between plants.

LOWER RIGHT . . . Forklift trucks quickly unload train after it automatically stops at its destination. Carriers may be lowered and raised independently for greater handling ease.

CUT COSTS WITH MONORAIL INTERPLANT TRANSPORT

Companies grow, production facilities expand and interplant handling of materials, parts, semi-finished and finished products become complicated and costly. Time and again a Louden Monorail Interplant Transport System has proved to be the perfect answer. And with Louden's Selectomatic Control, transport is automatic.

A good example is The Louden Selectomatic Interplant Transport System at the Eljer Company, Division of The Murray Corporation, Ford City, Pennsylvania. Recently, to increase plant production, another plant was built similar to the original plant. Shipping and docking facilities for both plants were retained in the original building, only the storage area was incorporated in the second. Therefore, it became necessary to get stock from the second plant to the shipping dock in the first plant. 1400 feet of Louden Monorail with three steel carriers provide the perfect answer. The Louden MotoVeyor pulls or pushes the carriers, opens and shuts doors and automatically stops at its destination . . . transport is speedy, trouble-free—regardless of the weather or road conditions, and completely unattended.

A Louden Selectomatic Transport System can do many things not required in the Eljer Company installation. It can automatically transport materials unattended from point to point anywhere in or about your plant, and can select the shortest and most direct route, opening and closing switches to its destination. It can travel from floor to floor and building to building, open doors to let itself through and close doors behind it. It stops promptly when there is a load ahead or when it does not have the right of way, and resumes travel when the way is clear. It stops accurately at its destination and even loads and unloads its own carriers with certain classes of materials. It returns empty carriers to point of origin or places itself in storage awaiting the next call.

Louden Automatic Materials Handling is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. Both the Louden field representatives and the factory engineers are highly trained specialists in the field of overhead materials handling. When you have materials requiring handling, lifting or transporting, call on Louden for suggestions. This will cost you nothing but may prove to be the most profitable move you have ever made.

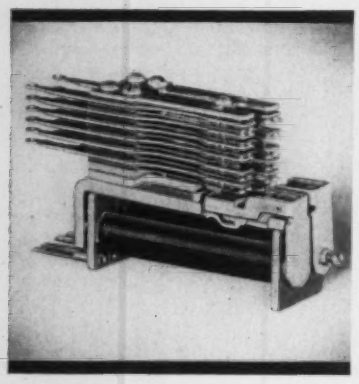
NEW **. . . 52 pages of illustrated applications . . . industry by industry. Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES."**

Louden
MONORAIL & CRANES

THE LOUDEN MACHINERY COMPANY
216 Broadway, Fairfield, Iowa
A subsidiary of Mechanical Handling Systems Inc.

SINCE 1867 . . . THE FIRST NAME IN MATERIALS HANDLING

Relays by Stromberg-Carlson



Telephone-type quality • reliability durability

If you require reliable, durable, top quality relays in the equipment you manufacture, you're well advised to consider the relays made by Stromberg-Carlson.

Hundreds of companies have found here the advantages based on our over sixty years of specialization in providing equipment and parts to the independent telephone world.

What's more, we go beyond just the manufacture of relays. If you desire, we can also provide wired mounting assemblies.

Our relays are available in a wide range of types, of which these are representative:

TYPE A: general-purpose. Up to 20 Form "A" spring combinations.

TYPE B: gang-type. Up to 60 Form "A" spring combinations.

TYPE BB: up to 100 Form "A" springs.

TYPE C: (illustrated) two on one frame. Ideal where space is tight.

TYPE E: characteristics of Type A, plus universal mounting. Interchangeable with other makes.

Types A, B, and E are available in high-voltage models. Our assembly know-how is available to guide you in your specific application.

Details on request from these Stromberg-Carlson offices: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

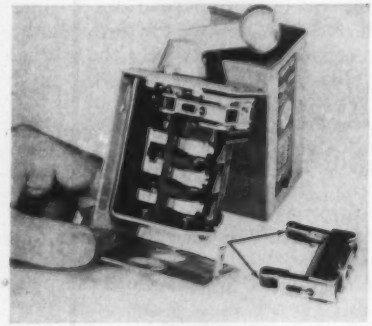
Circle 670 on Page 35

Plume named chief Electrodyne engineer of Hupp Aviation Div., Hupp Corp. . . . **William R. Orloff** appointed staff physicist at Molecular Electronics Inc. . . . **James W. Field** joined Packaging Institute Inc. as technical and field service director. . . . **Edward B. Maire** named general manager of Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. . . . **Thomas N. McGowen** named chairman of Hurletron Inc.

SPOTLIGHTING PLANTS

Kaiser Aluminum & Chemical Corp. is expanding its facilities in Chalmette, La. to increase its capacity for casting high-quality billets. The project is expected to cost approximately $2,000,000. . . . **Data Sciences Inc.** is the name of a new company formed to offer services in the analysis, design, and installation of systems for digital and graphic information handling. . . . **Dresser Industries Inc.** has formed a new division to be called Dresser Electronics. Scope of the new division will include all the activity in the electronics field of two subsidiaries, Southwestern Industrial Electronics Co., and Hermetic Seal Transformer Division. . . . **Durant Mfg. Co.**, producers of counting and measuring instruments, will begin construction on a 31,500 sq ft addition to its Instrument Division Plant at Watertown, Wis. . . . **Parker-Hannifin Corp.** has purchased the Span Brass Mfg. Co. and the Spanco Brass Sales Co. The two companies will be operated as the Spanco Brass Co. Div., Parker-Hannifin Corp. . . . **Atkron Inc.**, manufacturer of bottle and can handling equipment, has relocated its plant and general offices at Northampton, Ohio. The new building provides 24,500 sq ft of floor space. . . . **Allenair Corp.**, manufacturer of air and hydraulic equipment, is expanding its manufacturing and general office facilities by 20,000 sq ft. . . . **Hancock Telecontrol Corp.** acquired the Telecontrol Div., Hancock Industries Inc. The new company will manufacture and market production-data equipment. . . . **Controls Company of America** has organized a corporate research and development staff to carry out basic and applied research projects. Headquarters will be in Wauwatosa, Wis. . . . **General Electric Co.** has purchased a 243,000 sq ft building in Blue Ash, Ohio to house the Distribution Assemblies Dept. The structure will be the headquarters for the production of motor control centers and busways. . . . **Flo-Tronics Inc.**, manufacturer of electronic controls, materials-handling systems, and plastic products has purchased Rubber Industries Inc. and Plasticos Co. . . . **Ramo-Wooldridge, Div., Thompson Ramo-Wooldridge Inc.** has established an Intellectronic Research Laboratory. The laboratory will undertake fundamental

THE NEED for a cam follower which would operate for a minimum of one million cycles for a reversing drum switch, resulted in many tests on different materials at Allen-Bradley Co. Engineers were confronted with design requirements that called for a roller material which would resist excessive wear for the life of the switch, without need for replacement. Tests were run on various metals, nylon 101, and a prototype roller machined from molybdenum disulphide-filled sintered nylon, called Nylasint M4, manufactured by Halex Corp., subsidiary of Polymer Corp. The filled nylon roller lasted three times the number of duty cycles as the longest-wearing metal roller, made of full hard beryllium copper. In more tests of Nylasint M4, the rollers were not machined but made by a production process, similar to powder metallurgy techniques. Results showed that these rollers exhibited superior wear and impact resistance imparted by the filled nylon's permanent resilience and resistance to distortion, and in addition, provided a lubricity by the molybdenum. When tests were stopped, one roller had completed 1,491,000 operations and showed no failure to roll, and very little detectable wear.



A cylinder doesn't think but you do—and when you turn your thoughts to how a machine can perform, a lot of things can happen.

The cylinder responds instantly when activated, and does exactly what you tell it to do with pre-set adjustments. You can synchronize it with the motion of related machines or attach it to a moving machine.

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Circle 671 on Page 35

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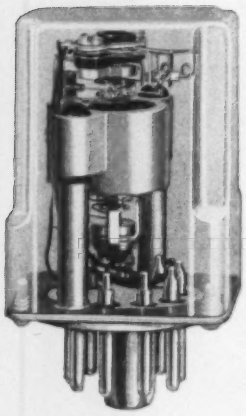

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Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of ±1 microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

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10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.

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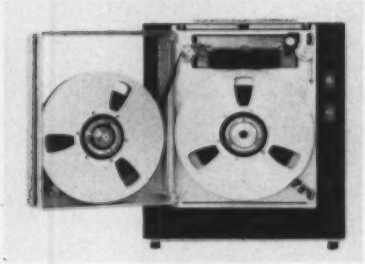
Chesterland 27, Ohio

S.A. 1903-C

Circle 672 on Page 35



STACKED-REEL, interchangeable tape magazine in an instrument-type tape recorder developed by Precision Instrument Co., achieves a reduction in size compared with conventional units where reels are mounted separately. Reel-to-reel and continuous loop models are available, with head spacing and track width conforming to IRIG standards in 2, 4, 7, and 14-track configurations, at all standard tape speeds. The recorder provides a frequency response from 50 to 200,000 cps at a tape speed of 60 ips for direct recording, with comparable response at lower speeds. For FM recording, frequency response is 0-20,000 cps at 60 ips, using standard 40 per cent deviation for full scale signal.

research in fields such as applied quantum mechanics, theoretical intellectronics, and the physical phenomena associated with computer components and devices. . . . **Instrument Div., American Electronics Inc.** is expanding its manufacturing and office space by 7,000 sq ft. . . . **Hapman Corp.**, manufacturer of conveyor products, has purchased Econ-O-Veyor Corp. and will operate it as a division of Hapman.

MEETINGS AND EVENTS

Feb. 7-9—

Society of the Plastics Industry Inc. Reinforced plastics division conference to be held at Edgewater Beach Hotel, Chicago. More details from society headquarters, 250 Park Ave., New York 17, N. Y.

Feb. 9-11—

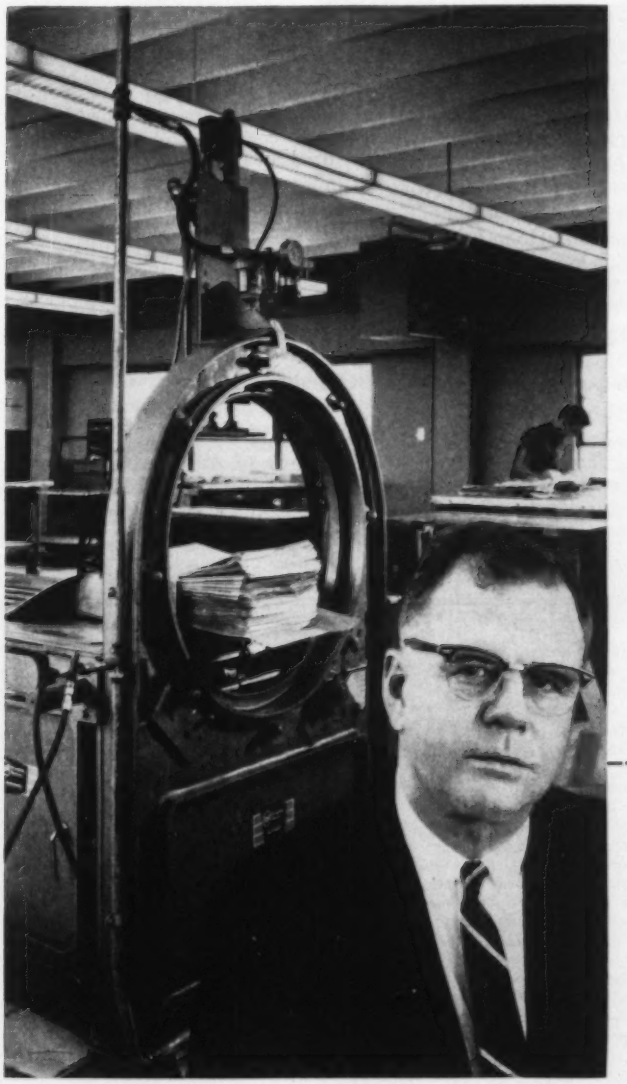
National Society of Professional Engineers. Winter meeting to be held at Hotel Fort Des Moines, Des Moines. Additional information from society headquarters, 2029 K St., N. W., Washington 6, D. C.

Feb. 15-17—

Solid-State Circuits Conference. Cosponsored by Institute of Radio Engineers, American Institute of Electrical Engineers, and University

IT'S BOUND TO BE BETTER WITH USS STEEL STRAPPING

"This automatic Round Steel Strapping machine doubles wrapping capacity, and cuts strapping costs in half."



"Since we installed the new Model 1200 Automatic Strapping Machine, we have jumped our capacity from 10 to 21 bundles per minute," says Mr. W. R. Cummins, Circulation Director, The Pensacola News-Journal Company, Pensacola, Florida. "And with our previous semi-automatic model we used twice as much round strapping. The new Model 1200 makes a tighter, more compact bundle, and we are now able to use one, rather than two strapping ties."

"With this new machine our circulation can jump to 115,000 without adding help," continued Mr. Cummins. "And since we installed the Model 1200, we've had trouble-free service."

The completely automatic Model 1200 compresses, wraps, tensions, and ties both small and large newspaper bundles with lightweight, high tensile, 18-gauge Round Steel Strapping. This strapping is economical and it holds papers securely. The Pensacola News-Journal Company chose this machine because, like all U. S. Steel Supply installations, it's dependable and it's backed up by always-available, technical service and assistance.

For further information about the advantages of USS Steel Strapping, both round and flat, and the applications of our automatic, semi-automatic, powerized and manually operated tying machines, please send the coupon.

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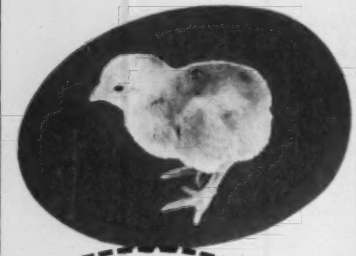
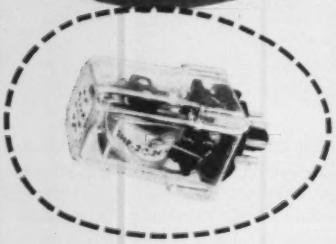
Circle 673 on Page 35

which comes first...





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Engineers at Elgin Advance are constantly working to keep Elgin Advance Relays up to the state-of-the-art. They strive to make each relay you buy today the relay you need today. When you specify relays, specify Elgin Advance — you'll get the relay that matches your needs.

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GHA — 5 amp resistive contact rating
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Contact arrangements are SPDT, DPDT and 3PDT

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Available enclosed in a dustite transparent cover or unenclosed

Enclosed relays available with 8-pin octal plug (SPDT, DPDT) and 11-pin plug (3PDT)

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THE ELECTRONICS DIVISION OF ELGIN NATIONAL WATCH COMPANY
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of Pennsylvania. To be held at University of Pennsylvania and Sheraton Hotel, Philadelphia. More information from Lewis Winner, 152 West 42nd St., New York, N. Y.

Feb. 22-23—

Seminar on Automation and Numerical Control. Sponsored by ASTME. To be held at the Bond Hotel, Hartford, Conn. Additional information available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Feb. 22-24—

Material Handling Institute Pacific Coast Show. To be held concurrently with the Materials Handling and Packaging Conference. Exhibits and technical sessions to be at the Cow Palace, San Francisco. Information available from William L. Dalton, 151 New Montgomery St., San Francisco, Calif.

Feb. 26-Mar. 1—

American Institute of Chemical Engineers. National meeting will be held at Hotel Roosevelt, New Orleans. Feature will be a petroleum and petrochemical exposition. More information from institute headquarters, 25 West 45th St., New York 36, N. Y.

Feb. 26-Mar. 2—

American Institute of Mining, Metallurgical, and Petroleum Engineers. Annual meeting to be held at Ambassador and Chase-Park Plaza Hotels, St. Louis. Information available from society headquarters, 20 West 39th St., New York 18, N. Y.

Feb. 27-Mar. 1—

Association of Iron & Steel Engineers. Western meeting to be held at Hotel Statler, Los Angeles. Additional information from association headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

Mar. 1-2—

Malleable Founders' Society. Technical and operating conference to be held Pick-Carter Hotel, Cleveland. Information available from society headquarters, 781 Union Commerce Bldg., Cleveland 14, Ohio.

Mar. 6-8—

American Management Association Data Processing Conference. Exhibit and conference to be held at the Statler Hilton Hotel, New York. More information from association headquarters, 1515 Broadway, Times Square, New York 36, N. Y.

Mar. 8-9—

Instrument Society of America. Conference on instrumentation for the iron and steel industry to be held at the Pick-Roosevelt Hotel, Pittsburgh. Cosponsored by the Metals and Ceramics Industry Div. and the Pittsburgh section of the ISA. Information available from A. W. Dudreck, College & Pike, Canonsburg, Pa.

Mar. 13-17—

Society of Automotive Engineers. National automotive and production meeting to be held at the Sheraton-Cadillac Hotel, Detroit. Additional

ELECTROSTATIC printer tubes that translate electronic signals into printed words or pictures have been developed by Industrial Components Div., Raytheon Co. The tubes can print up to three 8½ by 11-inch sheets per second from electrical signals transmitted by telephone, telegraph, or radio circuits. Direct inputs may be received from tape storage or instantaneous data generating sources. Physically, the tubes resemble flattened cathode ray picture tubes. Wires, 0.001-inch thick and spaced 250 to the inch, extend

brush-like through the faces of the tubes. When activated by a cathode ray beam, an individual wire will induce an electrostatic charge of corresponding intensity in paper passing against the tube. Pictures printed in this manner have a resolution similar to that of magazine illustrations. Applications for the new tubes include high speed printing of photographs, label printing, data printout, and transmission of handwritten records between remote points.

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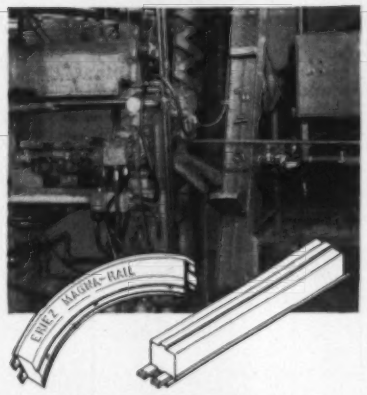
60 seconds that will help you improve operating efficiency.



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Do it magnetically . . . with MAGNA-RAILS — from the Eriez line of Magnamation® (magnetic automation) components.

Powerful magnetic action holds items ranging from tiny tacks to large finished parts at fast speeds, up or down inclines as steep as 90°. You can convey on top **and** bottom sides of your lines; turn parts over automatically; change direction of flow, etc.

Use of steep inclines shortens belt spans, permits close grouping of machines to conserve valuable floor space. Positive hold prevents slippage of parts — reduces damage, cuts need for manual handling, increases safety.

Eriez field engineers will gladly show you exactly how MAGNA-RAILS help you move materials faster, safer, more economically, more efficiently . . . either on new or existing lines. Write to:

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By using exactly the right magnetic material for a given application, Eriez can provide each customer with precisely the right equipment to do a particular job.

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Product Mgr. Automation

ERIEZ

A GROWTH COMPANY . . .
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 675 on Page 35

WORD COUNTER, operating at 60, 75, and 100 wpm speeds, automatically measures message traffic on teletypewriter circuits and shows the numbers on an illuminated face. Feature of the counter, developed by Western Apparatus Co., Div., Comptometer Corp., is a built-in transistorized line relay which permits a direct connection into any printing telegraph circuit with no inductive effect and negligible signal distortion. No auxiliary line relay is required.

information from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Mar. 16-17—

American Society of Mechanical Engineers. Textile engineering conference to be held at Clemson College, Clemson, S. C. More information from society headquarters, 29 West 39th St., New York 18, N. Y.

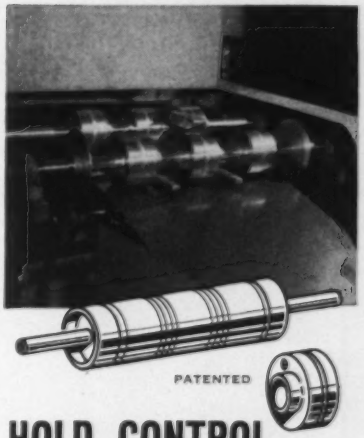
Apr. 17-19—

Fifth Conference on Manufacturing Automation. Cosponsored by Purdue University, Manufacturing Engineering Council, and AUTOMATION. To be held at Purdue University, Lafayette, Ind. For additional information contact: *K. E.* Glancy, Div. of Adult Education, Purdue University; or AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

"And this pushbutton starts the operation."

ERIEZ *Magnetic Minute*

60 seconds that will help you improve operating efficiency.



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HOLD, CONTROL, ELEVATE, CARRY

ferrous materials magnetically

Do it with MAGNA-ROLLS — from the Eriez line of Magnamation® (permanent magnetic automation) components. They're particularly valuable in speeding and simplifying sheet handling.

Use Magna-Rolls as magnetic head pulleys to carry ferrous materials up and over or down and under belt conveyor lines. Use them singly or in multiples for feeding, conveying and controlling parts on non-belt systems. As magnetic feeders to control and feed sheets, blanks and formed parts to various operations, and many other ways too!

Magna-Rolls can be furnished in diameters ranging from 2½" to 30". Erium® powered magnetic strengths and field depths can be furnished to meet specific requirements. In the wide range of standard and modified standard units you will almost certainly find a simple, economical solution to your specific handling or conveying problems.

Full data on Eriez Magnamation components is available in our newest Bulletin. Write for it to:

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Most of the very first installations of Eriez equipment are performing as effectively today as they did when they were new, years ago.

A. F. ISRAELSON
Chief Engineer

ERIEZ

A GROWTH COMPANY . . .
10 NEW PRODUCTS IN THE LAST 5 YEARS

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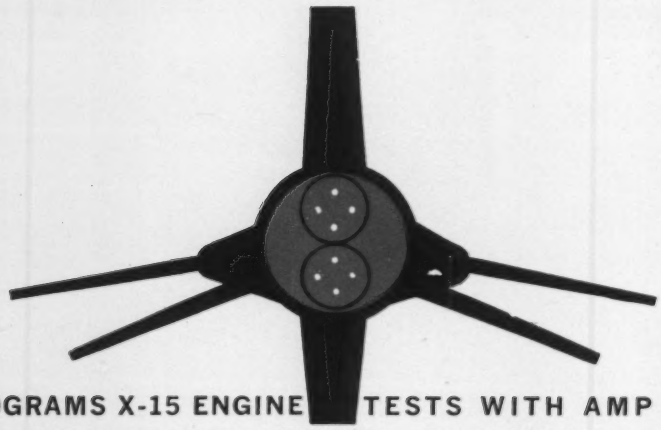
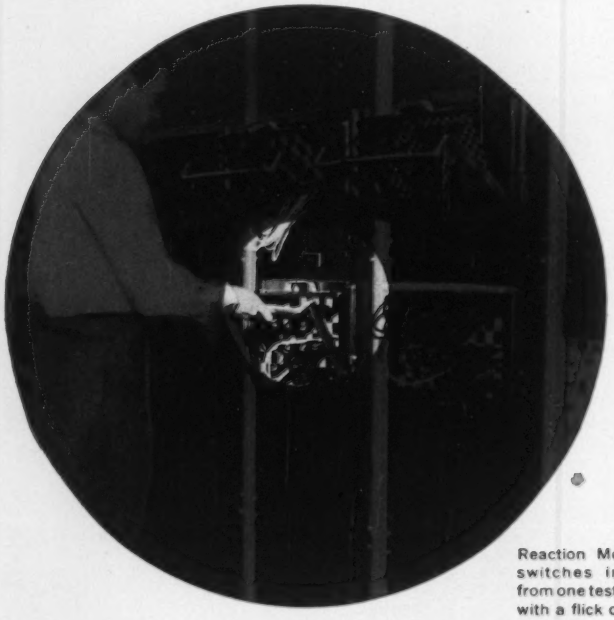


Thiokol PROGRAMS X-15 ENGINE TESTS WITH AMP PATCHBOARDS

To test the 50,000 pounds of whoosh in its new X-15 engine, Reaction Motors Division of Thiokol Corporation required versatile and reliable programming systems to connect instrumentation to six different test stands. With the assistance of AMP engineers, Thiokol installed six patchboard programming systems that can connect one set of test instruments of any of six test stands with a flick of the wrist—a saving of time, personnel and equipment. In addition to tremendous flexibility, AMP systems—either universal or shielded—provide a number of exclusive features including pre-cleaning of contact pins and springs, rugged take-a-beating construction, an almost unlimited range of sizes, plus electrical characteristics suited to the most sensitive applications—all contributing to top notch reliability. **For the complete story, write for our Patchcord Programming Catalog.**

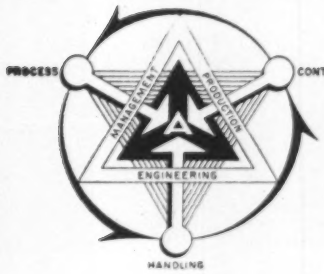


Reaction Motors' technician switches instrumentation from one test stand to another with a flick of the hand.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany



around the triangle.

COMPUTER CONTROL INVESTIGATED

Research program to investigate advanced concepts of computer control systems for chemical processes is being conducted jointly by E. I. du Pont de Nemours & Co. and the International Business Machines Corp. Contract for the program is scheduled to run until June 30, 1962, but a computer-controlled, chemical reactor is expected to be in operation at the Gibbstown, N. J. laboratory by the Fall of 1961. A catalytic process for making acrylonitrile is being studied. Sensitivity of the catalyst to operating conditions presents a problem in control since a given input of energy and material does not produce the same output each time. Research studies show that an improvement in the process is possible by adjustment which can be accomplished only through dynamic computer control.

LABORATORY FOR MANUFACTURING METHODS

Laboratory to study advanced manufacturing methods is to be built by General Electric Co. at Schenectady, N. Y. The $3,000,000 facilities will consolidate in one location six components now operating at various locations. Aim of the new center will be to provide the company with many of the tools necessary for product leadership while holding down costs. Scope of the laboratory's activity will be in the areas of research and development, teaching and counseling, and dissemination of data on manufacturing methods.

1960 GOOD YEAR FOR ELECTRICAL INDUSTRY

Electrical manufacturing industry reached an all-time high in 1960, with the value of factory shipments totaling $22,622,300,000. This represents an increase of 5 per cent over the 1959 total of $21,522,900,000, reports the National Electrical Manufacturers Association. Shipments of industrial equipment were up 5 per cent to $3,615.7 million; shipments of industrial electronics and communications equipment were up 20 per cent to $7,019.2 million. NEMA predicts total electrical shipments for 1961 about equal to 1960, with industrial equipment down 2 per cent and industrial electronics and communications equipment up 2.5 per cent.

MORE WORK BY THE NUMBERS

Ten additional tape-operated machines will be added to the production line at Republic Aviation Corp. All told, there will be fifteen tape-controlled machines, representing an investment in excess of $5 million, engaged in building the automatic, all-weather F-105D fighter-bomber. Currently, Republic's tape-controlled machine tool battery consists of two profilers, two skin mills, and a five-axis profiler. The additions will comprise four five-axis profilers, three three-axis profilers, and three all-around combination automatic units. Four of these machines use magnetic tapes, the rest use punched paper tape. Installation of the new units will be completed this year.

WOVEN BELTS SPLICED BY VULCANIZING IN PLACE

Woven carcass rubber conveyor belt is first of its type to successfully offer capacity to be vulcanized into an endless unit in the field. Conventional woven carcass belts are joined at the ends with mechanical fasteners or hooks and must be operated under reduced tension. The new belting, called Industrial Uniflo, is produced by Goodyear Tire & Rubber Co. especially for industrial and mining service. Vulcanized splicing was made possible by adapting Goodyear's compass uniplane splice. The belting is produced on an automated belt calendering machine in continuous lengths without cover seams and has a carcass of nylon-reinforced cotton yarn woven into a special interlocking complex.

AUTOMATION

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PLANTS COAST TO COAST

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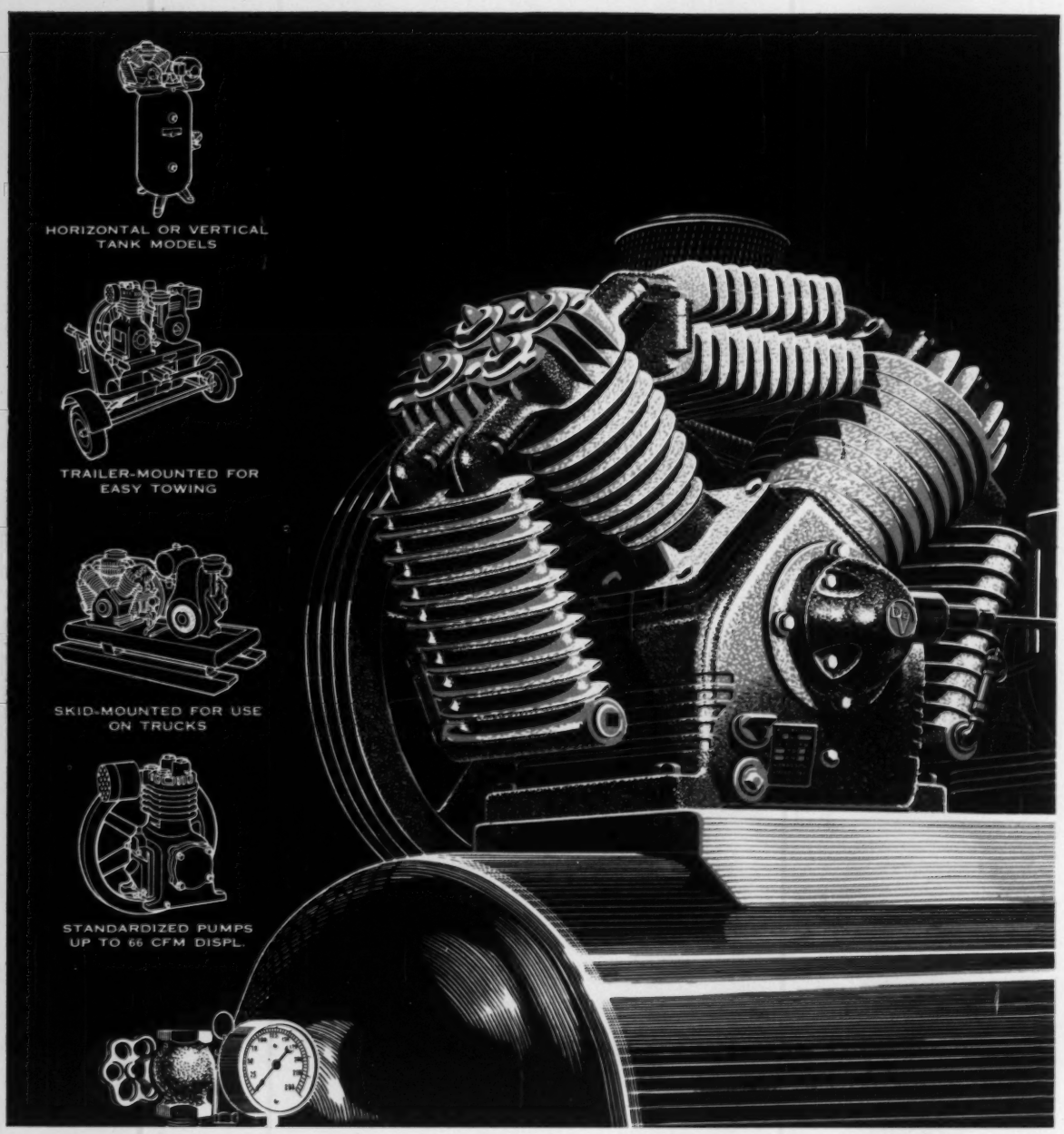
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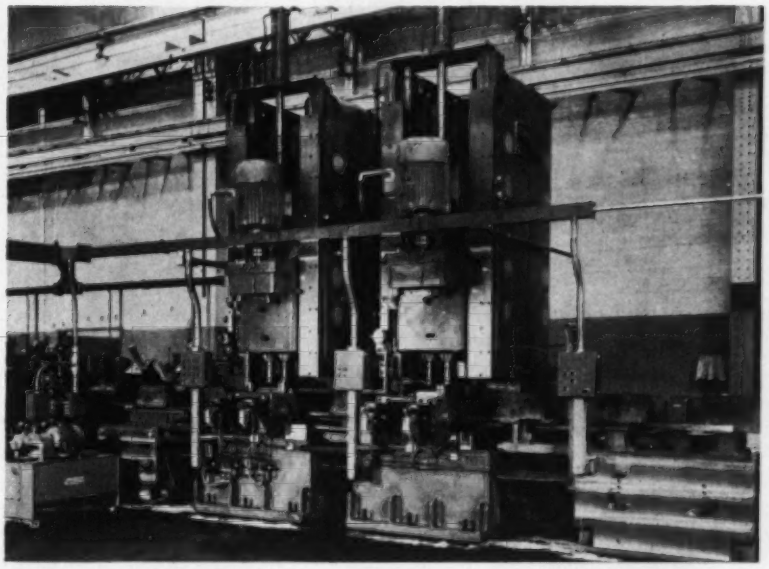
By JAMES C. KEEBLER, Editor



Alternate cylinders are bored in these twin stations near the end of Section 1. Centerlines of ways and boring spindles are in the same plane to improve accuracy.

Block Machining

THOSE of us who like our wagons long and low slung, yet go out and buy compacts have created considerable problems of facilities planning for the automobile industry.

If the manufacturer provides highly automated specialized facilities for one model because it is expected to be a big seller, and procures less comprehensive facilities for another model because it is expected to have smaller quantity production, and if the customer's performance turns out to be exactly in reverse, the manufacturer will be stuck with unused production capacity on one hand and stuck with inadequate facilities on the other.

The 1960 model year performance put many of the industry's plants in that situation, and the management quickly concluded that this is no way to make money.

Flexibility Required

Small wonder this topic was included as the subject of one of the four panel discussions planned by Production Activity of the SAE at the January International Congress and Exposition of Automotive Engineering held at Cobo Hall.

This was by far the biggest SAE meeting in history. Because of the international nature of this affair and the wide range of technical sessions and scientific exhibits, there was a big turnout. Verified show attendance was 21,000, some 40 per cent higher than the initial forecast attendance of 15,000, according to Dr. Andrew Kucher, vice president, research, Ford Motor Co. a member of the Exposition Advisory Committee and the 1960 SAE Board of Directors.

The four Production Activity panels were titled "Generating New Ideas on Production Processes," "Practical Applications of Operations Research," "The Automotive Industry Tackles Reliability," and "Securing Maximum Flexibility of Production Equipment."

This latter subject has gained considerable importance to automakers. Speaking as a member of that panel, Kurt Tech, vice president, engineering, the Cross Co. said: "Production plants today need and are getting three types of flexibility in their equipment. 1. The ability to adapt and change machines quickly and easily. 2. The ability to do a large number of different types of operations on a single machine. 3. The ability to process a variety of different parts on a single machine."

Recently, at a lecture at Harvard University Graduate School of Business Administration in Cambridge, Mass., James O. Wright, Ford Vice President-Car & Truck Group, indicated that it is no longer possible to predict with satisfactory accuracy the share of the market any automotive product is likely to obtain.

Mr. Wright added that as a result of the change in market situations, Ford is seeking unprecedented flexibility in manufacturing and assembly operations. "To improve flexibility, Ford is redesigning machines so that they may be used for production or assembly of more than one product," Mr. Wright said. "Whole assembly plants are being equipped so that more than one kind of car can be assembled on the same production line, and radical changes are being made in systems and procedures," he explained.

More Automated Equipment

This kind of thinking may well spell the end of "unautomated" production lines for automobile manufacture. Rather than risk being unable to supply customer de-

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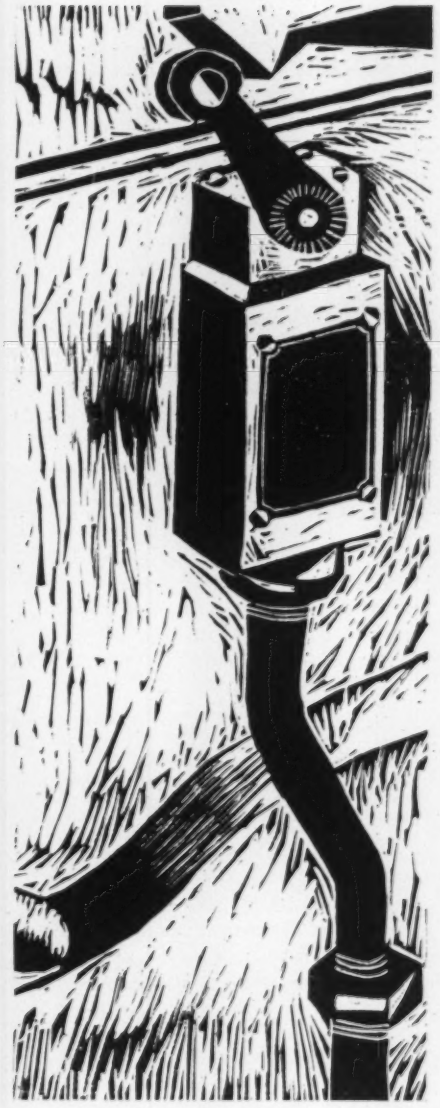

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1. Both operating head and switching element are completely sealed.
2. Arm locks in 870 positions, thru 360°.
3. Positive overtravel stop allows 60° overtravel either direction.
4. Captive cover screws cannot be lost.
5. Operating head may be faced in 4 directions.
6. Ample space for easy, fast wiring.
7. High-capacity switching element replaces without removing housing.
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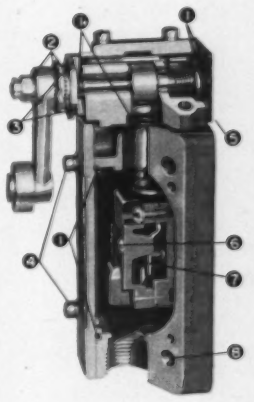

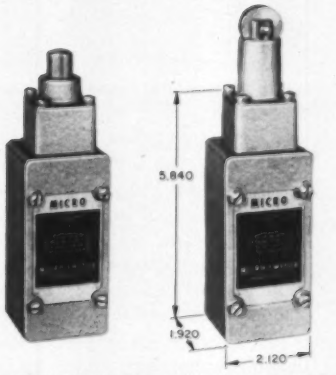

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Circle 680 on Page 35

mands, the automaker would rather add flexibility features to an automated line and then be in a position to quickly convert to anything that the customers buy like hot cakes.

This puts an added challenge on the ingenuity of the production equipment designer.

New Challenges

The advancing state of transfer-machine design is effectively illustrated by a new Transfer-matic that processes cylinder blocks for a four-cylinder engine. A major innovation in the machine, designed and built by the Cross Co., is the integration of all milling and cylinder boring with assembly and the many other operations required to finish the block. A design advantage of this machine is that uniform standards apply throughout the entire production line.

Briefly, cast-iron blocks, with their tops and bottoms broached, are loaded in Section I where heavy metal-removing operations are performed. In Section II, ends of the blocks are milled and cam bores are roughed. Following a banking conveyor, blocks enter Section III where their sides are machined. Section IV includes operations for drilling and tapping holes on the top and bottom of the blocks, and finish reaming the tappet holes. After they emerge from a washer, blocks enter Section V for bearing-cap assembly. In Section VI, the cam and crank bores are machined.

Cylinder Boring

As soon as blocks are loaded in Section I, they are rolled 270 degrees to dump any remaining broaching chips and to position the casting for processing the locating holes. Then the blocks are clamped and probed.

One probe simulates the camshaft boring-bar support and the other checks the block cavity for tappet-hole bushing-plate clearance. Probes are positioned by gravity and air circuits indicate interference. If there is interference, the block is removed from the line at the next station. Crank bearings of the good castings are straddle milled in the next working station.

Alternate cylinders are bored in pairs in two stations. Individual boring spindles are mounted in cartridges that are housed in water-cooled compartments to maintain constant operating temperature. The slide for each pair of spindles is mounted within a seven-ton cast column that is fastened on top of the base. Through special design of these units, the center lines of the spindles and ways are in the same plane to eliminate forces that would tend to divert the spindles from their true paths.

Milling Ends of Block

A simple rotary transfer bar slides castings through Section I with a 36-inch index. Section II uses a lift-and-carry transfer to clear the boring-bar support in this section. Indexes are only 24 inches because the blocks are crosswise of the line.

The advance and return strokes of Section II transfer bars are powered by the same hydraulic cylinders that return and feed the milling cutters. This is one example of savings that have resulted by including milling of the ends of the blocks in this line. A separate transfer mechanism is not needed.

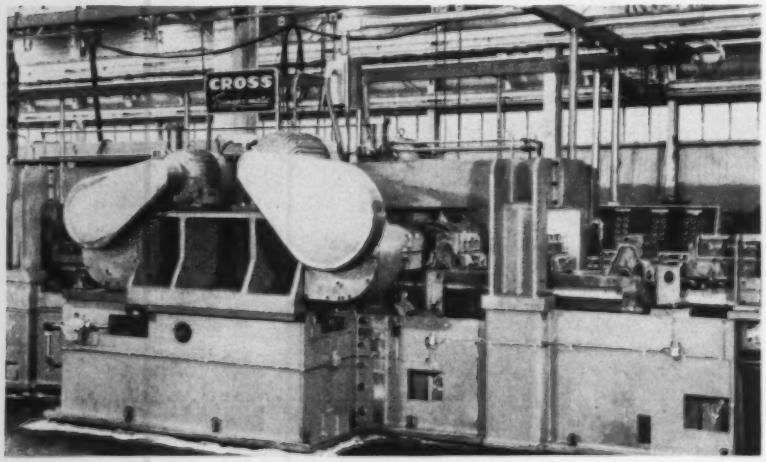
Two saddles—each with a roughing and a finishing head for one end of the block—are driven by separate hydraulic cylinders but their motions are mechanically tied together. At the end of a milling feed stroke, the ends of one block have been rough-milled, two rough-milled blocks are in idle stations between the cutting stations, the next block has been finish-milled and the transfer bars have been returned to the 'forward transfer' position (cutters feed in a direction opposite to that for block transfer). The transfer bars are then raised, and the saddles and bars move forward together, advancing all blocks one station and positioning the cutters for the next feed stroke.

In addition to obtaining a 'free' motion by integrating movements of the milling saddles and the transfer bars, this method results in zero relative motion between cutters and blocks during transfer. Cutter retracting movements are thus unnecessary because cutters do not move across machined surfaces.

In the remainder of the machine, operations are more conventional except for a drilling operation and a porosity check. Drilling of the oil-gallery holes is done (along with other operations) in six different stations. Since these drills are long and slender, each is monitored by a Cross Protect-O-Tool unit that will shut down the section if a drill breaks.

Chips are blown off the blocks and then the oil-gallery hole is plugged. Air pressure is introduced into the hole. If leakage occurs during the test period, the porous block is sprayed with yellow paint so it will be removed from the line without wasting additional work on it.

To process these blocks requires establishment and finishing of 123 assorted holes and several surfaces. The line maintains high block accuracy, and its design is sufficiently flexible to accommodate block-design changes.



Ends of the blocks are milled in these stations. Part transfer is from right to left, milling-cutter feed stroke is from left to right. There is no relative movement between the cutters and the blocks while the blocks are being transferred.

REALITY IN AUTOMATION

Fork trucks that automatically stack, retrieve and transport... tractor trains without drivers... automated overhead handling equipment... push-button, robot-like machines to do your bidding—

THIS IS THE POWER ONE MAN CONTROLS WHEN HE PUSHES THE BARRETT BUTTON...

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☐ Arrange film showing, "New Horizons in Material Handling"

Name.....Title.....

Company.....

Street.....

City.....Zone.....State.....

Circle 681 on Page 35

RAPISTAN Ideas HANDLING

RAPISTAN TAKES A "WIDE-ANGLE" YOUR TOTAL ACCUMULATION AND

Have you counted your warehouses lately? Not to inventory the items in them — but to identify them, wherever they may be found in your operations?

Counting warehouses is not as far-fetched as it may sound. Although most businesses readily recognize two or three warehousing areas — shipping, receiving and central storage areas, for example — this is only part of the story.

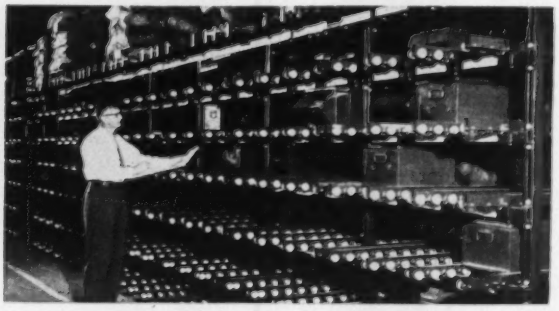
When the flow of materials through any plant is analyzed, build-ups of work are frequently found before and after many operations. Regardless of the volume of material involved, these constitute real warehousing problems that may be costing you more than you realize.

By streamlining and simplifying the operation of your major and "hidden" warehouses, you can gain better utilization of space and control of inventory, assure first-in-first-out use of materials, cut down on spoilage and damage costs, and cut out much lost time and wasted motion.

This method of parts storage is typical of many manufacturing plants. All the parts needed at this part of the line are here, if the workers can find them. Rapistan warehousing principles treat such build-ups of material as true warehousing problems.

(Below) Optimum quantities of all parts needed at the same assembly station now are stored in Live Storage Flow Racks, loaded from service aisles. No time is lost in walking and searching — no interruptions for delivery of supplies.

This central storage area (above) is typical of many industrial plants. Stacked bins and boxes defy efficient handling. Wide aisles required by lift trucks waste additional floor space. Rapistan warehousing principles (below) reduced the floor space of this central storage area by 4,500 sq. ft. and added 10,000 more sq. ft. of storage capacity. Parts now stored in Rapistan Flow Rack are instantly accessible; inventory control is simplified, and FIFO use of stock is automatically enforced. Space is used to the full cube capacity.



CONSIDER TIME ELEMENT, TOO

Goods need not remain at rest for days or weeks to constitute a true warehousing situation. In modern concepts of efficient handling, where accumulation must be closely coordinated with other functions of the flow system, warehousing problems can result from materials being stopped or stored for as little as a few minutes. In fact, since such short-term stop-overs usually involve frequent rehandling, rapid turnover can be more costly than long-term storage would be.

MAKE MATERIALS "CONVEYABLE"

The "condition" of the materials to be handled also has a relationship to your accumulation problems. In many situations, the key to gaining the advan-

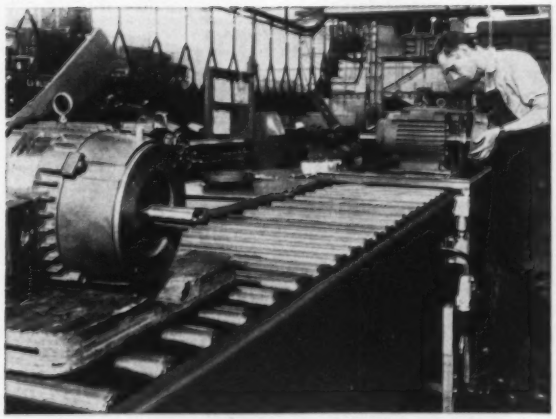
VIEW TO SOLVE MOVEMENT PROBLEMS

tages of live storage for "problem" parts is to place them in a "conveyable" condition.

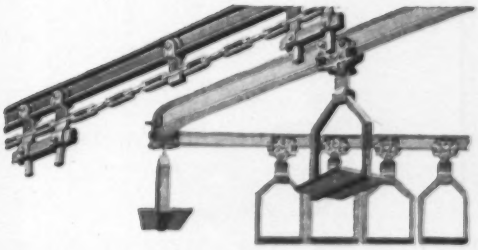
If you've rejected the application of advanced warehousing principles to the storage of certain items because of their size, shape, weight or handling requirements, you may be denying yourself cost savings that could be yours. Simple, low-cost standardized containers may allow you to store such materials on wheels or rollers, where they belong, for reduced handling and easy accessibility. Low-cost pallets, tote boxes, and trays or simple carriers for overhead trolley conveyor, often can serve as suitable containers for even the most unwieldy objects.

Your Rapistan engineer is trained to look beyond the obvious, recognize accumulation problems wherever or whenever they exist. He will recommend practical solutions that promise profits in lower-cost, more efficient handling methods. If you'd like to see some examples of how Rapistan's modern warehousing techniques and coordinated handling systems have paid off for others — manufacturers, wholesalers, retailers and service industries — send for this "Handbook of Materials Handling Ideas."

Circle 728 on Page 35



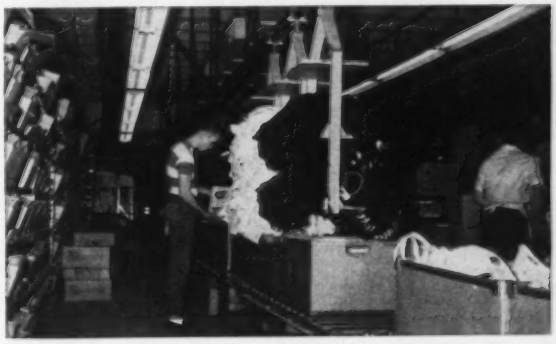
Heavy generator parts in this plant are "warehoused" for short times at several points in the progressive assembly operations. Low-cost wooden pallets serve as standardized containers for these otherwise "non-conveyable" objects.



POWER and FREE is a complete and versatile overhead flow system

Rapistan Power-and-Free conveyor systems give you full-time control of materials in motion on overhead conveyor. You can automatically direct the flow of goods or parts to work stations, accumulation points, into temporary or long-term storage — and recall loads selectively whenever and wherever needed for most efficient materials flow.

Overhead Power-and-Free conveyor can be integrated into an existing or new floor-mounted conveyor system, as in this garment manufacturing plant. This is a transfer area, where materials are unloaded from the overhead "free" line to containers on the floor conveyor.



Even when different time cycles are involved for individual processing operations, Rapistan Power-and-Free lets you coordinate and control the entire flow pattern for maximum efficiency. Many manual handling operations can be eliminated or made more efficient, by a simple, trouble-free Rapistan Power-and-Free overhead conveyor system.

For information on Rapistan Power-and-Free Conveyor in industrial processing and warehousing applications, write for this new illustrated brochure.

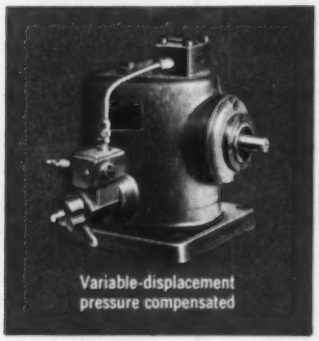
Circle 682 on Page 35

Rapistan®

CONVEYING EQUIPMENT

The RAPIDS-STANDARD COMPANY, Inc.

530 Rapistan Building, Grand Rapids 2, Michigan



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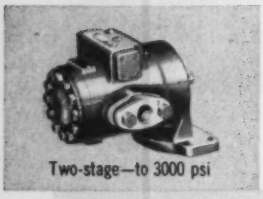
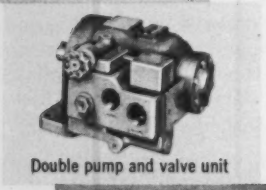
- You are assured of simplified service and reduced inventory requirements with Vickers replaceable cartridge and repair kits.

For more complete information, write for 70-page Catalog 5001C.

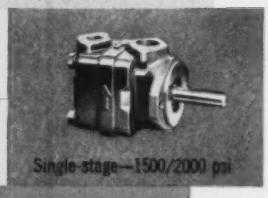
Single stage—to 1000 psi



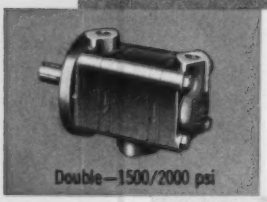
Two-stage—to 3000 psi



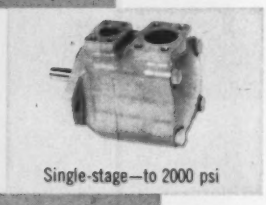
Double pump and valve unit



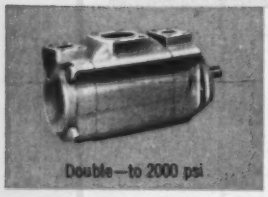
Single-stage—1500/2000 psi



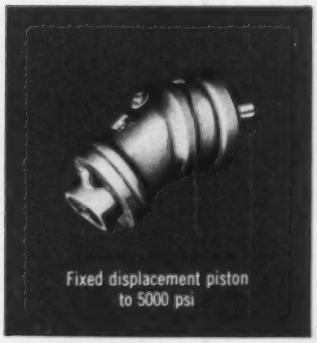
Double—1500/2000 psi



Single-stage—to 2000 psi



Double—to 2000 psi



Fixed displacement piston to 5000 psi

9139

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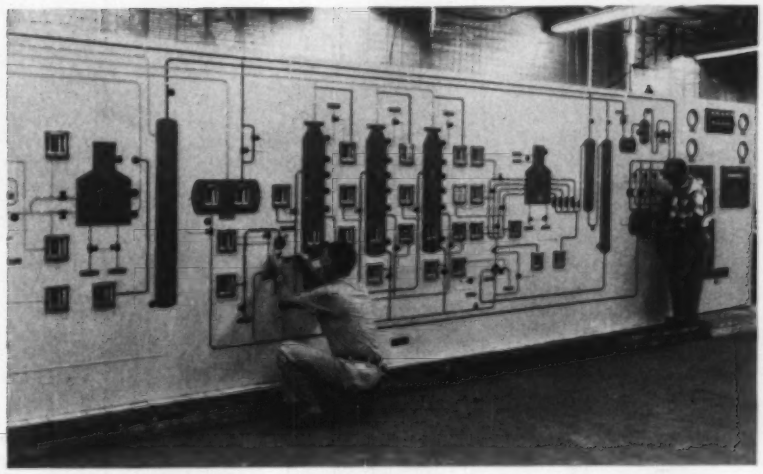
international scene



Rio de Janeiro, Brazil—Shown in final stages of construction is one of five instrumented control panels being built by Brown Instruments Div., Minneapolis-Honeywell Regulator Co. for the Duque de Caxias Refinery of Petroleo Brasilerio. Instrumentation includes miniature pneumatic indicating, recording, and controlling devices as well as electronic potentiometers and pressure gages. Graphical representation on panel corresponds to process flow diagram, with instruments placed at control or measuring points. The new refinery, for which Foster-Wheeler Corp. is contracting engineer, will use an island in the Rio de Janeiro harbor as an unloading station for crude oil and a loading site for refined products. A 10-mile long pipeline will connect the island with the eight-unit refinery on the mainland. Capacity will be 90,000 barrels per day of crude oil.

EDP in France

IN LATE 1955, the Society of French Railroads began a study to determine the feasibility of using an electronic data processing system to help improve the over-all efficiency of its operations. Included in the study were all phases of the business—administrative, operating, and research. The project is now taking final form with the installation of a large EDP system in a new central control office near the railroad station at Auteuil-Boulogne.

As part of the feasibility study, the railroad sent a mission to the United States in 1957 to learn the latest developments in computer applications and techniques. Information gathered by the mission representatives indicated that a multiplicity of applications existed for use of a computer in railroad operations. Accordingly, five special work groups were set up, each charged with responsibility for a specific project area—personnel, operations, compatibility, etc.

At the same time, the General Studies Service of the railroad organization undertook to weigh the relative merits and capabilities of various computers available on the market. The first point established by this group was that single EDP systems were available that could handle all of the operations anticipated. This opened the way to the centralization, at one location, of all computer-controlled data processing functions.

In successive stages, the administrative functions of the railroad will be transferred to the new center at Auteuil-Boulogne. The first stage concerns personnel records processing, and will involve computer control of the preparation, ordering, and accounting of 340,000 monthly wage bulletins for the agents comprising the permanent cadre of the railroad.

Other computer controlled administrative functions will follow. These include accounting control of merchandise in freight cars (national and international) and the rapid preparation of commercial statistics on merchant traffic.

Subsequently, the system will establish statistics of train and car movements, with a wide choice of shunting and economical distribution of empty cars. Railroad stocks will also be co-ordinated, with the expectation that a reduction in total inventories will result.

Finally, the EDP system will be available as a permanent research tool for the railroad. Scientific analyses, such as the calculation of train hours, will be conducted rapidly and efficiently with the aid of the computer.

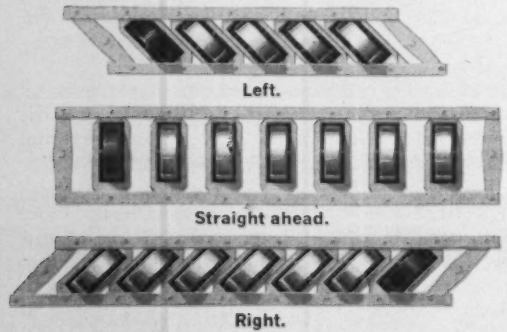
The EDP system chosen by the railroad is a product of the Paris firm of Compagnie Des Machines Bull. Designated Gamma 60, it consists of a central unit and various functional elements. Included are a central memory capable of storing 200,000 digits, an arithmetic and logic unit, a translator, and a comparer.

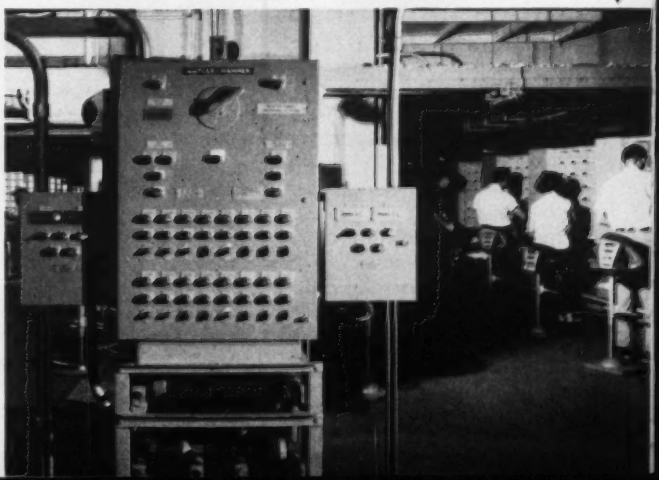
Internal checking is extended to all data processing functions in the Gamma 60. For example, internal data transfers, data processing operations, and data read-in or printout are all checked automatically. Once an error is detected, an error routine will be executed. If the error is due to

On command from the card reader (left above) the skate wheel assembly turns, sending the tray where it is supposed to go.

Main control panel shows status of mail tray flow on conveyors. The inspector can tell at a glance which sorting station needs mail.

The Cutler-Hammer skate wheel assemblies can be supplied in any width to meet varying conveying situtations.





What's new in control for automation?

How an idea and a roller skate wheel doubled the capacity of the Denver Post Office Conveyor System

Cutler-Hammer solution can also be used to increase capacity of industrial conveyor lines.

The assignment was to engineer a "Mail-Flo" system into the new Denver Post Office. This system is a method of routing mail from one sorting station to another on series of conveyors.

Displaying the kind of ingenuity that has increased the efficiency of many other materials handling systems, our engineers developed an idea involving a unique roller skate wheel assembly that doubled the system's capacity.

Formerly, metal arms were used as diverters to shunt the mail trays from one conveyor to another. There had to be at least a tray space between the trays to allow the arm to move back and forth. Cutler-Hammer engineers devised a simple, inexpensive diverter using a roller skate wheel assembly that allowed the trays to follow one another with little space in between. Result? A "Mail-Flo" system *with twice the capacity and no increase in cost.*

The importance of the electrical control man. The control man can bring to your automation planning team experience from hundreds of different automation problems—small and large—and from many different industries. The earlier you call him in the better. He can save false starts. He can help you develop the most efficient methods to automate at the lowest practical costs.

What's new from Cutler-Hammer. We're ready for the great technological growth of the sixties with new, better products, new engineering talent, new plant capacity—in fact, a new spirit. We'd like to show you how we could help you with your plans for automation. Put in a call to the nearest Cutler-Hammer sales office. Do it soon.

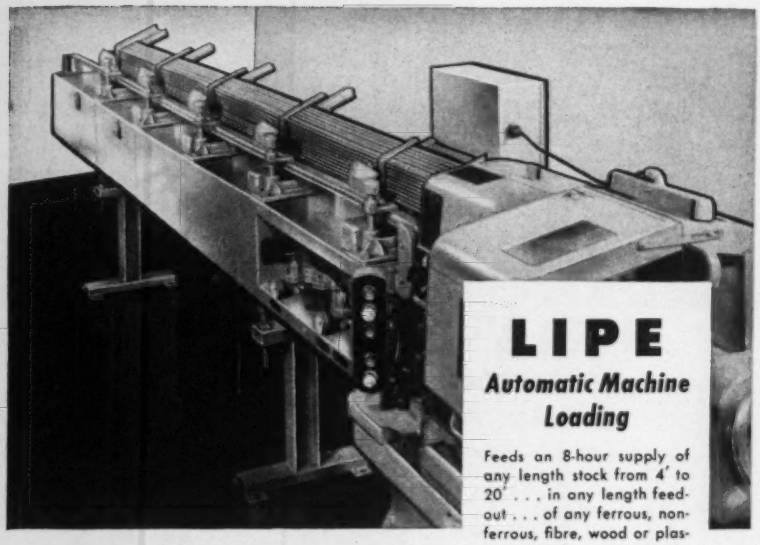
Automation is more efficient when the Cutler-Hammer man is called in early

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

Circle 684 on Page 35


LIPE
Automatic Machine Loading
Feeds an 8-hour supply of any length stock from 4' to 20' . . . in any length feed-out . . . of any ferrous, non-ferrous, fibre, wood or plastic material . . . ranging in diameter from 1/16" to 1 1/2".

Continuous Automatic Feed

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LIPE AML Bar Feeds will give you faster, finer production with less scrap and refinishing and a more efficient use of manpower.

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LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

the malfunction of an element, the system is stopped (partially or completely) and the type of error and source are indicated on a console.

Bedfordshire, England

Process announced by Khan & Co. Ltd. is capable of producing hats from synthetic fibers at the rate of six per minute. The firm's production is presently confined to shapes that resemble fine straws, but development of an imitation felt is expected soon. Two special machines are used in the process. One machine processes the materials from which the hats are made, and the other applies heat to mold the material into a permanent design. Research is being conducted in collaboration with the British Allied Boot & Shoe Research Association to adapt the process to the manufacture of footwear. Other applications are foreseen in the foundation garment trade and the clothing industry.

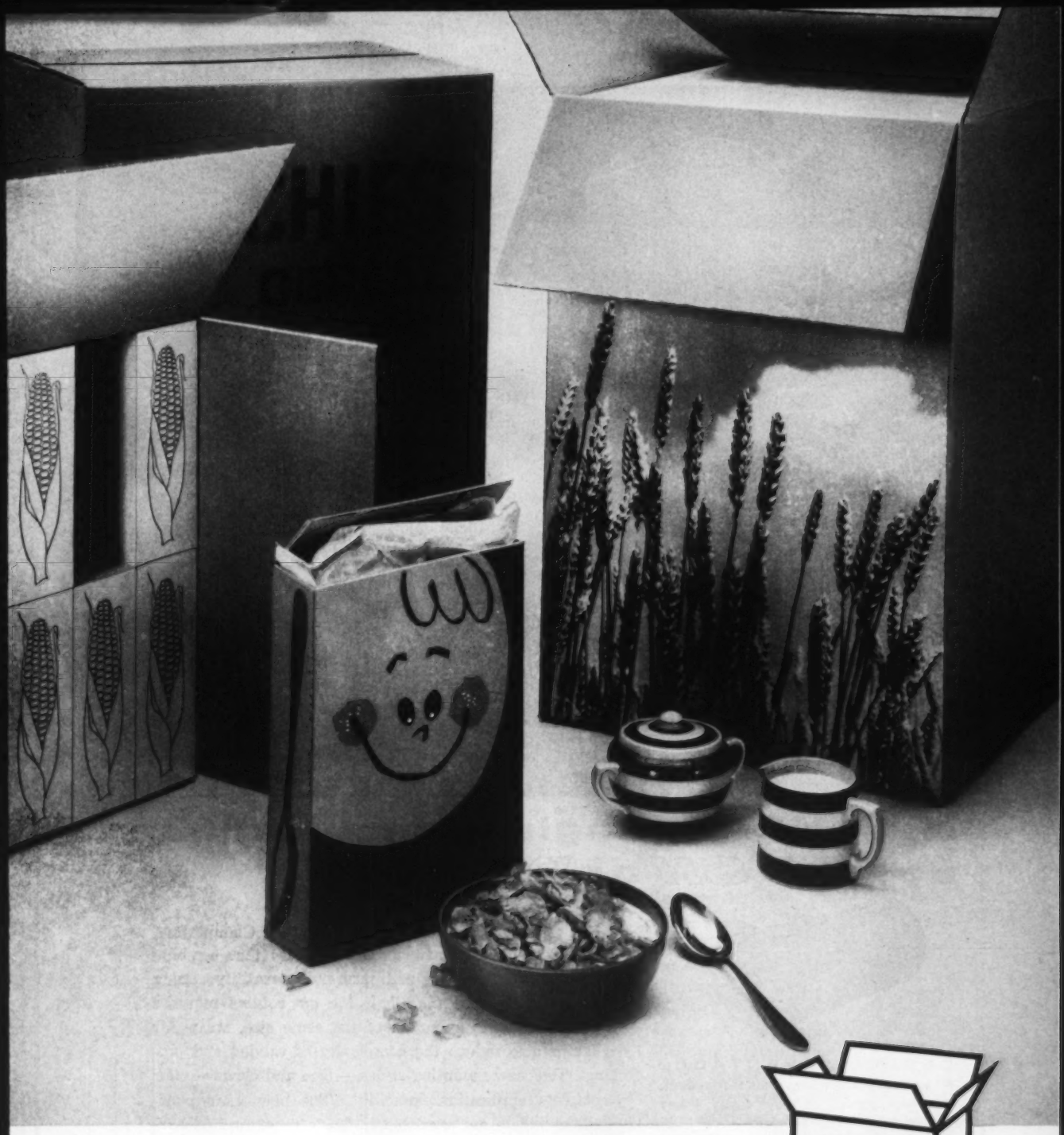
The Netherlands

Three United States manufacturers have recently concluded arrangements to produce scientific instruments, production equipment, and controls in the Netherlands. One of the companies, Baird-Atomic Inc., has acquired a major share of the stock of Electronisch Kernfysisch Apparatenfabriek N.V., The Hague. New name of the Dutch company is Baird-Atomic Holland N.V. Some Baird-Atomic instruments will be added to the overseas firm's production, which has been primarily that of nuclear physics instruments. Long-range plans include the production of a few instruments (in which labor cost is a major factor) for U. S. consumption.

Branson Instruments Inc. has formed a subsidiary, Branson Europa N.V., in Loosdrecht near Amsterdam. A range of products developed in the U. S., including ultrasonic cleaning and test equipment, will be manufactured overseas.

Brooks Instrument Co. Inc. has announced the formation of a subsidiary, Brooks Instrument Nederland N.V., with headquarters and factory in Veenendaal, Netherlands. Eventually, the entire product line of the U. S. firm—including rotameter-type flow instrumentation, level controls, and primary-device components—will be produced for European consumption.

Circle 685 on Page 35



Millions of breakfasts in corrugated

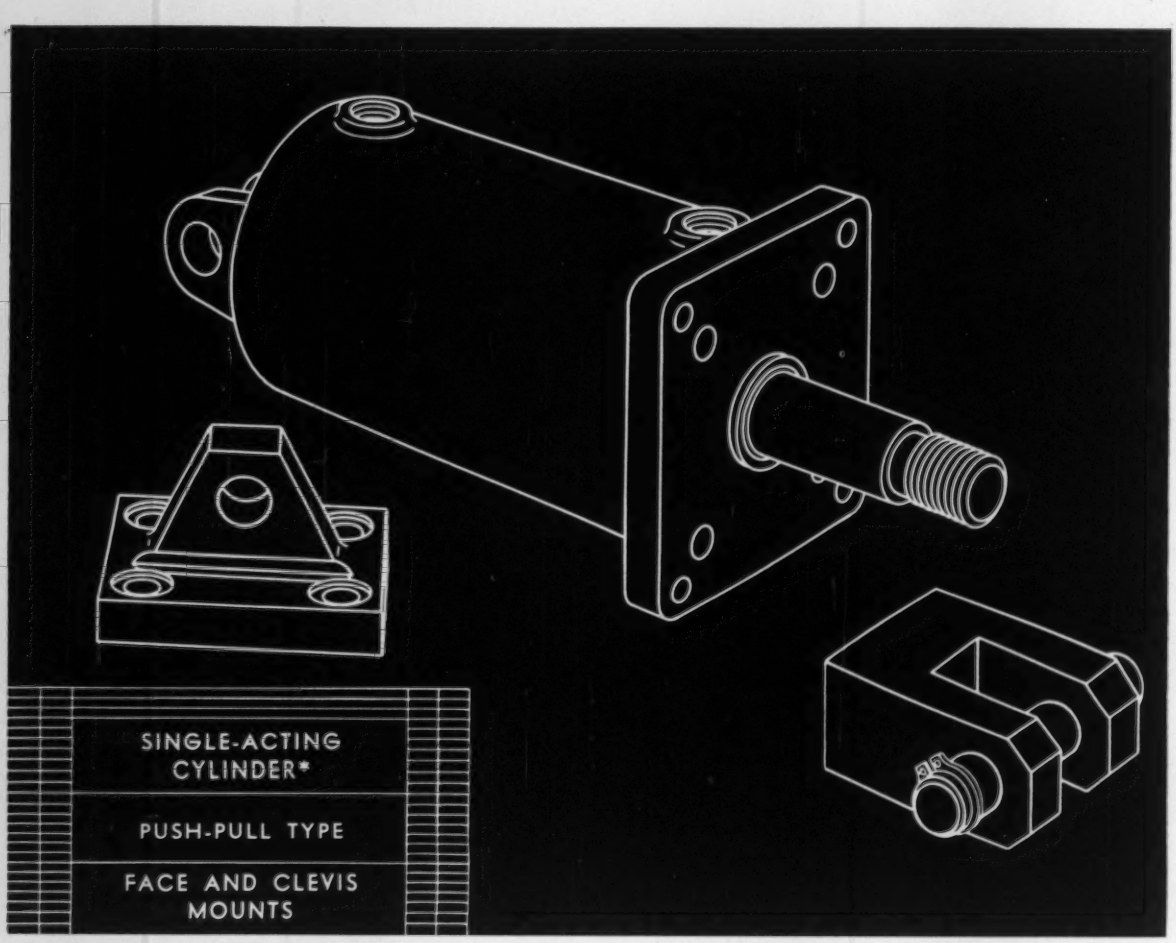
America's big morning appetite is a bull market for breakfast food. Producers supply this demand with a harvest of crispness, a multitude of different cereal brands. Why are so many of these family favorites shipped in boxes by Hinde & Dauch Division? Because buyers know they can depend on Hinde & Dauch for money-saving *corrugated containers in volume.*

West Virginia Pulp and Paper

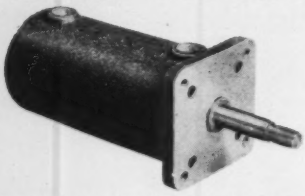
Hinde & Dauch Division

17 Plants • 42 Sales Offices • Sandusky, Ohio

Circle 686 on Page 35



New MEAD single-acting cylinder can *PUSH* or PULL



DESIGN ADVANTAGES

- Pressure tightening seals throughout.
- 3-way instead of more costly 4-way valve may be used.
- Conical return spring assures long life and uniform tension.
- Return spring recessed in cover for compactness.
- Oilite rod cartridge provides durable wearing surface.
- Air consumption considerably less than that on double-acting models.
- Full floating double-up piston cup for extended life.

Wherever a job calls for pushing, squeezing, lifting, holding, tilting or sliding, there's a place for MEAD Air Clamps.

*May be used as a double-acting cylinder if desired.

With the latest addition to its famous "Air Clamp" line, MEAD presents two new mounting styles that combine spring-return simplicity with push-pull versatility. Using *only slightly more than half the air volume* required by double-acting cylinders of the same size, MEAD Air Clamps also reduce the complexity of valving and piping. Two new mounting styles — face and clevis — offer complete application flexibility. The new MEAD push-pull cylinders are available in 2¼", 3", 4" and 5" bore sizes with 1", 2" or 3" strokes.

For further details and information on fast delivery and economical prices, write MEAD *today*.

PRODUCTS FOR AUTOMATION

MEAD

FLUID DYNAMICS

A DIVISION OF MEAD SPECIALTIES CO.
4114 N. Knox Ave., Dept. 221, Chicago 41, Ill.

ASK YOUR MEAD MAN for more dollar-saving automation ideas

Circle 687 on Page 35

Squeezed Profits

In reports on the state of the business nation there are causes for celebration and reasons for wailing at the walls. Compared to other nations of the world, the USA is clearly ahead in technical, economic, and social stature. But recent performance comparisons give cause to question our ability to negotiate successful technical, economic, and social readjustments with our neighbor countries in a fast developing world.

Abroad as at home the best competitors take the lead. Wide diversities of conditions in other lands serve to increase the foot-frontage of the frontiers of competition. This makes business on a global basis much more hazardous than for stateside operation.

On corporate levels, these new business conditions have created both a smile and a frown. Some companies are setting all-time records and others are on the rocks. Presently there appear to be an alarming number of companies with high sales volume and low profits.

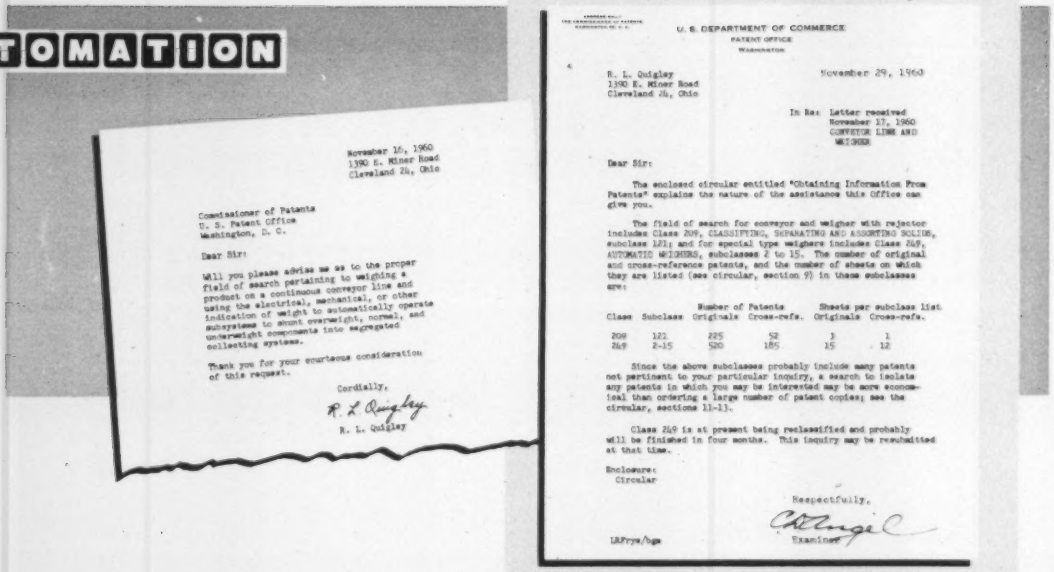
It takes two pressures to make a squeeze. Forces of competition push prices downward. Increased complications of engineering, manufacturing, and selling products (and paying taxes) force costs upward. Profits are squeezed in the middle.

Whether your company has profits to burn or is feeling the pinch, increased attention to automatic manufacturing operations offers rewards for you. Those looking for places to put some money would be well advised to increase their manufacturing engineering staff and expand their automation programs, or buy an extra feasibility study. Such moves are destined to strengthen their positions. Those who desperately need improved production methods, in order to keep from sinking, must upgrade underautomated facilities. For them this is imperative for survival.

James C. Keebler

EDITOR

AUTOMATION



November 16, 1960
1390 E. Miner Road
Cleveland 24, Ohio

Commissioner of Patents
U. S. Patent Office
Washington, D. C.

Dear Sir:

Will you please advise me as to the proper field of search pertaining to weighing a product on a continuous conveyor line and using the electrical, mechanical, or other indication of weight to automatically operate subsystems to shunt overweight, normal, and underweight components into segregated collecting systems.

Thank you for your courteous consideration of this request.

Cordially,

R. L. Quigley

R. L. Quigley

U. S. DEPARTMENT OF COMMERCE
PATENT OFFICE
Washington

November 29, 1960

R. L. Quigley
1390 E. Miner Road
Cleveland 24, Ohio

In Re: Letter received
November 17, 1960
CONVEYOR LINE AND
WEIGHER

Dear Sir:

The enclosed circular entitled "Obtaining Information From Patents" explains the nature of the assistance this Office can give you.

The field of search for conveyor and weigher with rejector includes Class 209, CLASSIFYING, SEPARATING AND ASSORTING SOLIDS, subclass 121; and for special type weighers includes Class 265, AUTOMATIC WEIGHERS, subclasses 2 to 15. The number of original and cross-reference patents, and the number of sheets on which they are listed (see circular, section 9) in these subclasses are:

		Number of Patents		Sheets per subclass list	
Class	Subclass	Originals	Cross-refs.	Originals	Cross-refs.
209	121	225	52	3	1
265	2-15	520	185	15	12

Since the above subclasses probably include many patents not pertinent to your particular inquiry, a search to isolate any patents in which you may be interested may be more economical than ordering a large number of patent copies; see the circular, sections 11-13.

Class 209 is at present being reclassified and probably will be finished in four months. This inquiry may be resubmitted at that time.

Enclosure:
Circular

Respectfully,

Examiner

LAFrye/hgs

Fig. 1—The first step in searching patents relating to a field of interest is to identify the classes and subclasses containing patents in that field. The Patent Office will answer mail inquiries concerning the proper field of search without charge and will provide a list of classes and subclasses which could contain copies of patents pertaining to the subject matter of the request. A typical letter of request and an answer from the Patent Office are shown.

USING PATENT LITERATURE EFFECTIVELY

Although most often employed as an "after the fact" source to prove the uniqueness of new invention, patent literature can also be used as a "before the fact" tool to generate new ideas for solving manufacturing problems. To aid in the advantageous use of this material, the author describes the classification system for patents and explains several methods of searching for and obtaining pertinent patents. To illustrate the value of patent literature, typical examples of useful devices found in old patents are discussed.

By **HUGH A. KIRK**, Patent Lawyer, Toledo, Ohio

AVAILABLE in many public libraries around the country and in the Patent Office Search Room, Washington, D. C., is a virtually unlimited source of technical information and know-how on components, equipment, and systems that can be used in engineering automated production lines. This technical information is in the form of issued patents which contain an invaluable chronological record of engineering knowledge and can serve as a stimulus for further development in almost every field. Since the issuance of the first patent on July 31, 1790, almost 3 million patents have been granted for mechanical, electrical, and chemical inventions.

The judicious use of patent literature can save considerable time in determining the state of art in a particular field of development and in eliminating costly duplication of effort. In addition to serving as a source for prior art knowledge, patent literature can be used to generate new ideas by disclosing not only the good ideas of a development but also bad, undesirable features. Pitfalls encountered by other developers and recorded in patent literature can be recognized and avoided before money and effort have been expended.

Classification of Patents

A deterrent to the use of patent literature as an engineering know-how source is a prevalent feeling that such information is difficult to obtain. This feeling is definitely not based on fact. To simplify search of patent literature, the Patent Office has arranged the patent collection into subject matter classes and subclasses. At the present time there are over 300 main classes of patents which are identifiable by a number and a title, for example, *Class* 1—*Nailing, Stapling, and Clip Clenching*. Each of these main classes contains too many patent copies for ease of searching a particular phase of a class, and so they are further divided into numerous small classifications called subclasses. There are more than 56,000 subclasses which are also identified by a number and a title describing specific details or features of the patents in the subclass; for example, a subclass of Class 1 is *Subclass* 187—*Magazine Supply of Elements*.

Issued patents may be examined in the Patent Office Search Room in Washington, D. C., or in any of the 21 public institutions listed in TABLE I. To aid in determining the proper class and subclass for a particular engineering project, there is available at these search areas a *Manual of Classification* in which is listed an alphabetical index of all main classes of patents and a numerical index of main classes under which are listed all pertinent subclasses. For example, under the subject of Weighers are found 18 main classes of patents which cover subjects such as automatic supply control, packaging machine combined, and traversing hoist. If the problem concerns automatic supply control of weighers, the search classification would be Class 249. By referring to this class number in the manual, you would find that there are 66 subclasses on this topic.

Once the Class and Subclass numbers have been determined, the issued patents pertinent to these classifications can be located by referring to a yearly copy of *Index to Patents* which lists by patent numbers all of the patents issued in a particular year in each class and subclass. For example, in the *Index to Patents*-1959 under the classification for Discharge Weigher, 249-16, you find that two patents had been issued in 1959. These were patents 2,890,-013 and 2,914,291. A complete patent search would require that the classification be searched in all of the published year books.

Fortunately, most of this preliminary leg-work can be eliminated by referring your field of search to the Commissioner of Patents, U. S. Patent Office, Washington, D. C., as shown in *Fig.* 1. In response to mail inquiries, the Patent Office will advise individuals as to what patent classes and subclasses to search. It is essential that you state positively and definitely what it is that you want to search, and what it is supposed to do. Your letter of inquiry is kept secret, the contents are not published, and you

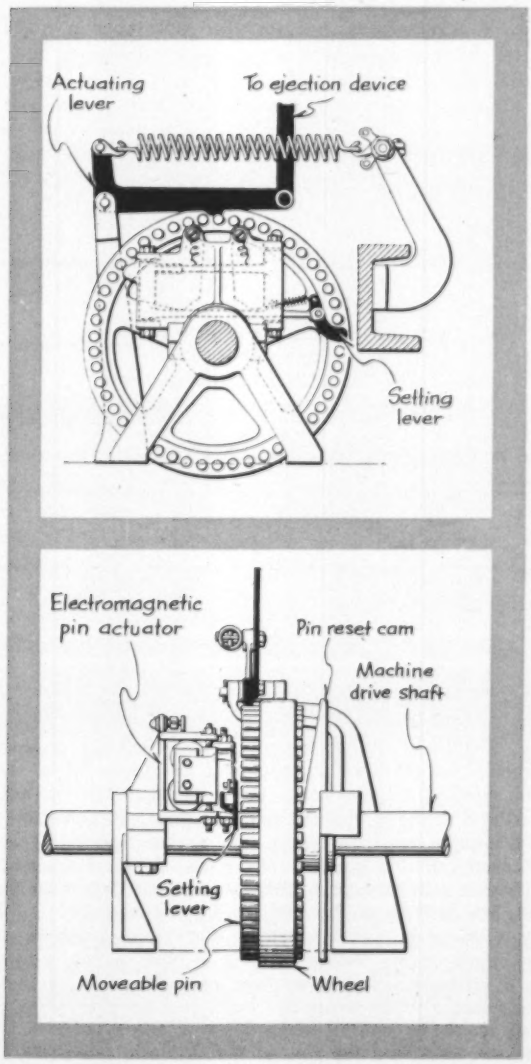
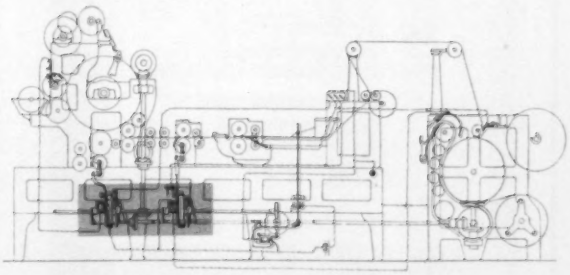


Fig. 2—Mechanical pin and wheel memory device is disclosed in Patent 955,221 issued in 1910. Electromagnetic pin actuator causes a pin to be displaced on the wheel when a roll splice is detected at the supply end of the bag machine. The pin wheel revolves in time with the passage of the splice through the machine. After the paper containing the splice has been formed into a tube and cut to length, the displaced pin causes the actuating lever to drop, actuating an ejection device to remove the faulty tube section from the machine. Similar pin and wheel memory devices have been used in recent times in parcel sorting systems to store destination data and to initiate removal of parcels onto spur conveyors.



do not have to reveal your idea or concept to anybody to obtain information.

After analyzing your field of search, the Patent Office will send a letter which lists the classes and subclasses pertinent to your problem and the number of original patents and cross-reference patents in each subclass. There also will be a tabulation of the number of sheets required to list both the original and cross-reference patents in each subclass. Each sheet can contain up to 100 patent numbers, and a separate sheet is required for each subclass. These sheets can be purchased from the Patent Office at a price of 30 cents each.

As a further aid to developers, the Patent Office has prepared microfilm lists of patent numbers in each of its subclasses, and many of the listed libraries have this film available for use. Once the class and subclass has been determined by individual efforts or by mail inquiry to the Patent Office, the developer can refer to the microfilm list for patent numbers and then read the listed patents for technical information that might be of interest to his own development. Since many of the lists will contain hundreds of patent numbers, it is advantageous to eliminate the patent numbers of least interest. When the list has been narrowed down sufficiently, the developer can purchase copies of the remaining patents from the Patent Office.

▶ Using Patent Literature

When the prior art patents have been received from the Patent Office, close examination of the drawings, specifications, and claims can provide a wealth of knowledge concerning prior attempts to solve problems similar to your own. As each patent is examined, the developer can learn exactly why the prior patent was deficient, and this knowledge can spark new ideas that probably wouldn't have developed without this source of literature. In many cases, the knowledge attained may be sufficient to eliminate previous planned avenues of development and to suggest entirely new ones.

In addition to obtaining possible solutions to current engineering problems, the time spent in examining prior patents may lead to an entirely new development that may be patentable in itself. In this connection, it might be noted that a basic doctrine of the Patent Office is that a new use for an old element is not invention, and therefore is not patentable as such. However, a patent may be granted to the inventor or discoverer of any new

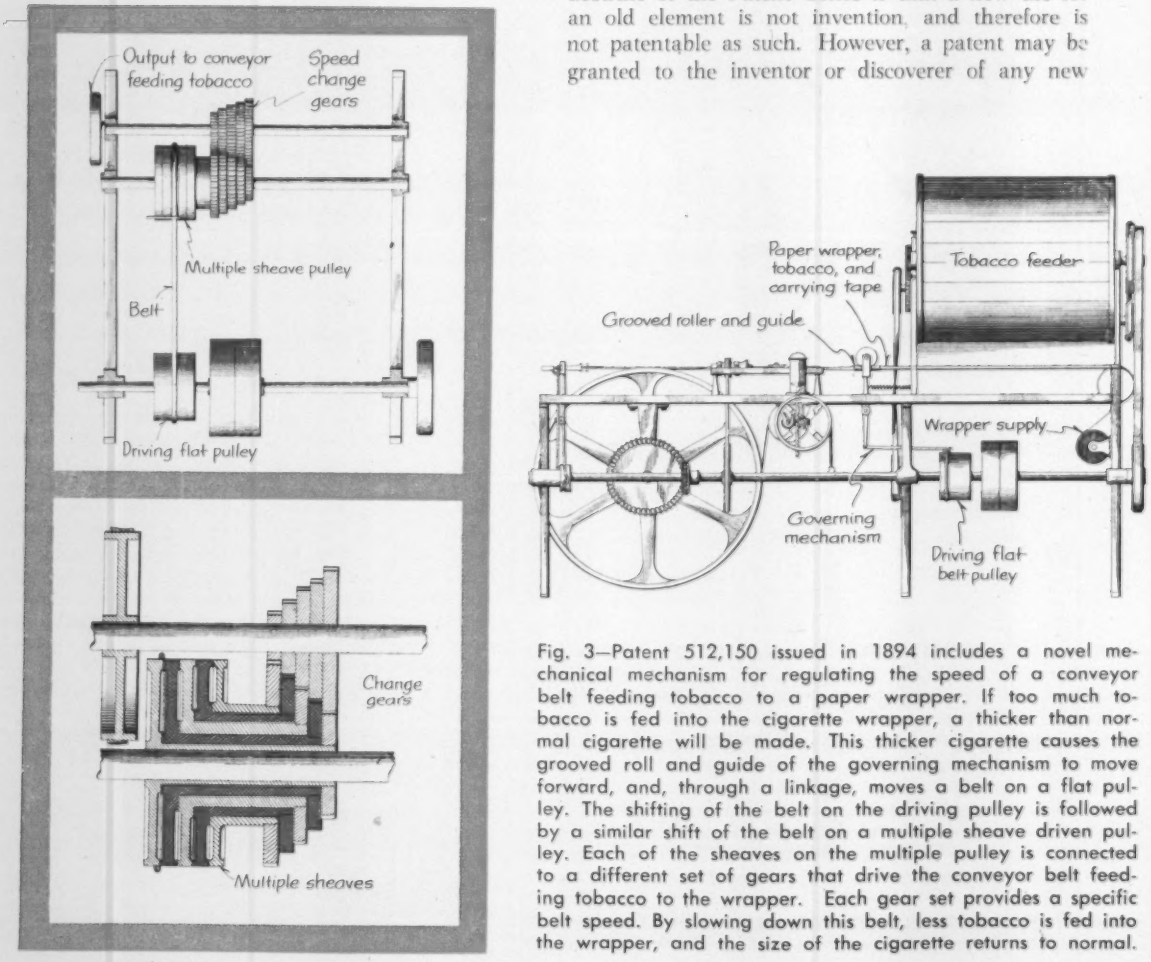


Fig. 3—Patent 512,150 issued in 1894 includes a novel mechanical mechanism for regulating the speed of a conveyor belt feeding tobacco to a paper wrapper. If too much tobacco is fed into the cigarette wrapper, a thicker than normal cigarette will be made. This thicker cigarette causes the grooved roll and guide of the governing mechanism to move forward, and, through a linkage, moves a belt on a flat pulley. The shifting of the belt on the driving pulley is followed by a similar shift of the belt on a multiple sheave driven pulley. Each of the sheaves on the multiple pulley is connected to a different set of gears that drive the conveyor belt feeding tobacco to the wrapper. Each gear set provides a specific belt speed. By slowing down this belt, less tobacco is fed into the wrapper, and the size of the cigarette returns to normal.

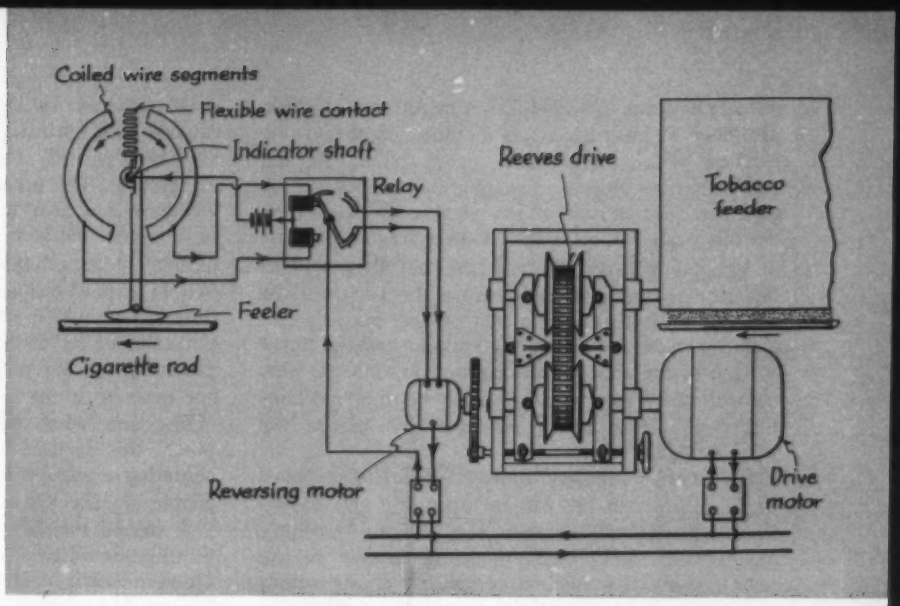


Fig. 4—In 1932 Patent 1,864,728 was issued for an electro-mechanical system for varying the feed of tobacco into a cigarette wrapper in accordance with changes in cigarette density. A feeler, riding on top of a cigarette, moves up and down as the tobacco density changes. This movement is transmitted to a flexible wire contact which periodically is cammed against one of two coil wire segments. This causes one of two coils in a mechanical switch to be energized, actuating a switch and changing current flow to the field windings of a reversing motor. The reversing motor changes the speed ratio of a variable speed drive, causing the tobacco feeder to increase or decrease the flow of tobacco into the cigarette wrapper.

TABLE 1—Locations of Libraries that Maintain Printed Copies of U. S. Patents

City	Library
Albany, N. Y.	University of the State of New York
Atlanta, Ga.	Georgia Institute of Technology Library*
Boston, Mass.	Public Library
Buffalo, N. Y.	Buffalo and Erie County Public Library
Chicago, Ill.	Public Library
Cincinnati, Ohio	Public Library
Cleveland, Ohio	Public Library
Columbus, Ohio	Ohio State University Library
Detroit, Mich.	Public Library
Kansas City, Mo.	Linda Hall Library*
Los Angeles, Calif.	Public Library
Madison, Wis.	State Historical Society of Wisconsin
Milwaukee, Wis.	Public Library
Newark, N. J.	Public Library
New York, N. Y.	Public Library
Philadelphia, Pa.	Franklin Institute
Pittsburgh, Pa.	Carnegie Library
Providence, R. I.	Public Library
St. Louis, Mo.	Public Library
Stillwater, Okla.	Oklahoma A. & M. College Library
Toledo, Ohio	Public Library

*Collection incomplete.

and useful process, machine, manufacture or composition of matter, or any new and useful improvement thereof.

A patent is granted for seventeen years, after which time anyone can use the invention disclosed. The term of a patent may be extended only by special act of Congress, and this condition occurs very rarely and only in the most exceptional cases. After the term has expired, any one has a free right to use an invention covered in an expired patent, so long as he does not use features covered in other unexpired patents in doing so. This is based on the fact that a patent is a contract between the inventor and the Government in which the inventor agrees to disclose his inventions so that anyone skilled in the art can reproduce the invention. For this consideration, the Government gives the inventor the exclusive right to prevent others from making, using, and/or selling the disclosed invention for a limited period of time, namely, seventeen years.

Regarding the patentability of automation itself, after interviewing many Examiners in the Patent Office, it is felt that the present Patent Office doctrine is that even automation encompassing the integration of work performing machines, handling systems, and control arrangements is not patentable, unless it can be adequately proved that new and unexpected results are obtained over what would be expected by summing up the performances of separate individual elements or machines.

In order to illustrate the type of useful technical knowledge that can be obtained from patent literature, a search was made of some very old, less known machines that could contain typical examples of automatic work performing, handling, or control techniques. Some of these early patents are of interest because they document the invention of automated machines long before automation became an industrial concept, and others are of interest because they describe novel techniques that could be useful today. Representative patent classes and subclasses were selected in which it was felt that automatic machinery would be found, and in each subclass one or more automatic machines were selected for discussion.

▶ Manufacturing Patents

In a class devoted to boot and shoe making, Patent 9,629 was issued in 1853 to S. D. Tripp for a machine which would automatically peg shoes according to a change in the curvature of the sole. This machine is a very early example of mechanical integration of work performing, handling, and con-

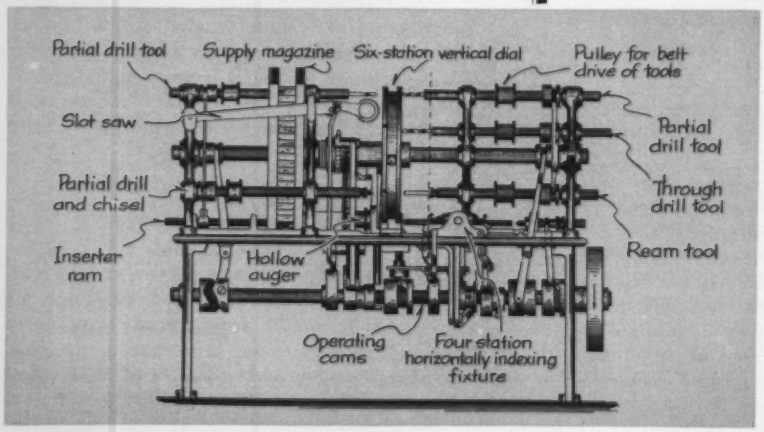
trol mechanisms to accomplish a manufacturing task. The shoe to be pegged was mounted on a movable carriage which rode on a curved track. As the carriage was indexed through the machine, the shoe last was moved under pegging mechanisms—one on each side of the last—which made a hole in the last with an awl, fed and split off a wooden peg from a peg strip, and drove the peg into the last. The vertical movements of the pegging mechanisms were guided by the curvature of the upper surface of the shoe, and horizontal movements were controlled by cam wheels. Each pegging mechanism would insert pegs from the middle of the heel to the middle of the toe.

In another industry Patent 955,221 was issued to C. B. Stillwell in 1910 for operating and control improvements to a paper bag making machine. Several interesting innovations are covered in this patent. One is a method of splicing a new supply roll to the old supply roll without stopping the machine. The location of the splice joint is detected and stored in a mechanical memory device so that the joint can be ejected from the machine before it reaches the bag bottoming mechanisms. A second innovation is a mechanism for detecting a badly formed bag bottom and storing this information until the defective bag can be ejected from the machine. Other detecting devices consist of electrical feeler fingers at several points on the machine which stop the machine and register on an indicator when the paper web is misaligned or has holes in it, or when a bag tube has holes in it.

Of particular interest are the mechanical memory devices used on this machine, for similar devices have been recently used in an automated parcel sorting system. The memory device used to store splice locations is shown in *Fig.* 2. This device consists of a wheel containing approximately 50 movable pins on its periphery. When a flying splice is made to join a new roll onto the machine, an electrical contact is actuated which causes an electromagnetic pin actuator on the memory device to laterally displace one of the pins. The wheel rotates in synchronism with the travel of the splice in the machine, and when the splice reaches the ejection point, the displaced pin causes a lever to drop, actuating a gripper device to remove the faulty tube containing the splice.

A second memory device of similar design stores information when a bag has a badly formed bottom. However, this memory device performs a second function in addition to removing the faulty bag. If a second faulty bag is detected before the first bag is ejected, the two pins displaced in this case trip a mechanical lever and cause the machine to stop. In both memory devices, the displaced pins are mechanically reset after each revolution of the wheels.

Automatic machinery has been used for a long time in the tobacco industry, and Patent 512,150 issued in 1894 to W. C. Briggs is probably a basic patent on cigarette making machines. In this machine a regulated quantity of tobacco stock is fed onto a continuous wrapper formed into a U-shape



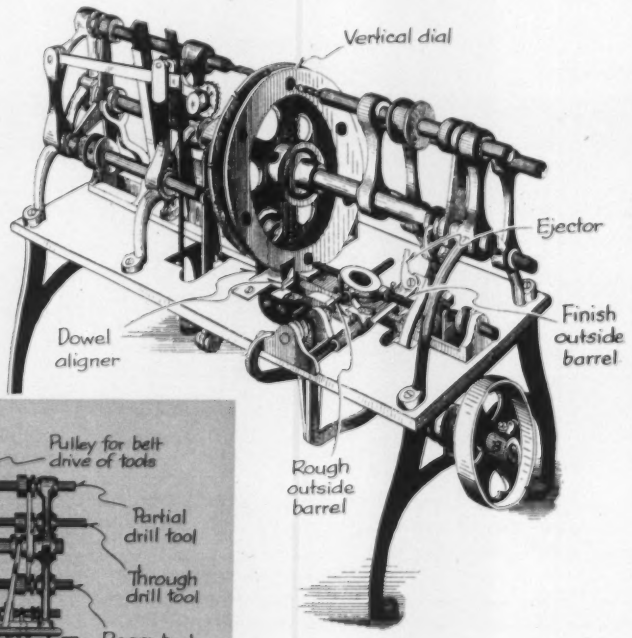


Fig. 5—This automated machine was patented in 1876 to manufacture thread bobbins from blocks of wood. The machine includes a magazine feed for the wood blocks, a hollow auger for cutting the blocks to dowel form, a six-station vertical dial for moving the dowels through a series of drilling, reaming, sawing, and chiseling operations, and a four-station indexing fixture for handling the bobbin while the outside of the barrel is cut and finished. All tools are belt driven, and all handling and machining mechanisms are cam operated.

by a flexible carrying tape. The tobacco, wrapper, and tape are guided through a governing mechanism which controls the supply of tobacco, depending upon the thickness of the three elements. Paste is then applied to one edge of the wrapper, and a folding channel causes the wrapper edges to overlap and seal. During this time the tape is also folded completely around the cigarette. After the unit passes through a spinning tube to finish seal the wrapper, the tape and cigarette are separated, and the cigarettes are cut to length.

The governing mechanism that controls the supply of tobacco fed to the wrapper is an interesting part of this patent and is shown in *Fig.* 3. If too much tobacco is fed onto the wrapper, a thicker than normal cigarette and tape combination will pass through the groove roller and guide trough of the governing mechanism, causing the mechanism to move forward and, in turn, shift a belt connecting a driving flat pulley with its driven pulley. The driven pulley is actually composed of a series of parallel sheaves, each of which is connected through a concentric shaft to a cone gear. Thus, by shifting the driving belt from one driven pulley to another, a different gear ratio is set up for driving an output shaft. This output shaft is connected by belts and gears to a conveyor belt which feeds tobacco to a distributing and carding drum, which in turn, feeds tobacco to the cigarette wrapper. When the governor mechanism is pushed forward, the conveyor belt is slowed, reducing the supply of tobacco to the wrapper. Conversely, as the governor mechanism moves backward, the conveyor feed is increased.

Another device for controlling the feed of tobacco into a cigarette wrapper was patented by W. J. Hawkins in 1932. Patent 1,864,728 discloses a mechanical feeler, *Fig.* 4, that rides on top of a cigarette rod prior to cutting. As the density of the cigarette rod varies due to too much or too little tobacco, the feeler follows the variations with a slight up and down movement which is transmitted by a rod linkage to an indicator shaft by means of a rack and gear. A flexible wire contact, attached to the indicator shaft, is caused to rotate by the feeler and moves from a neutral position to either side over coiled wire segments. Periodically, a driven cam causes the contact wire to move against a coiled wire segment, establishing an electrical circuit which is used to actuate the tobacco feed drive through a relay and a variable speed drive. The system also can be adapted to control tobacco feed through a relay and a variable potentiometer, through a small reversing motor and a variable speed drive, or through a thyratron tube control and driving motor.

Another advance in the same field was made in 1944 and disclosed in Patent 2,357,861 issued to U. A. Whitaker. This machine uses an electrostatic apparatus which measures the amount of electrical current passing through a cigarette. When the density of a cigarette varies from normal, the apparatus causes the faulty cigarette to be ejected from the machine, and at the same time increases or decreases the tobacco feed.

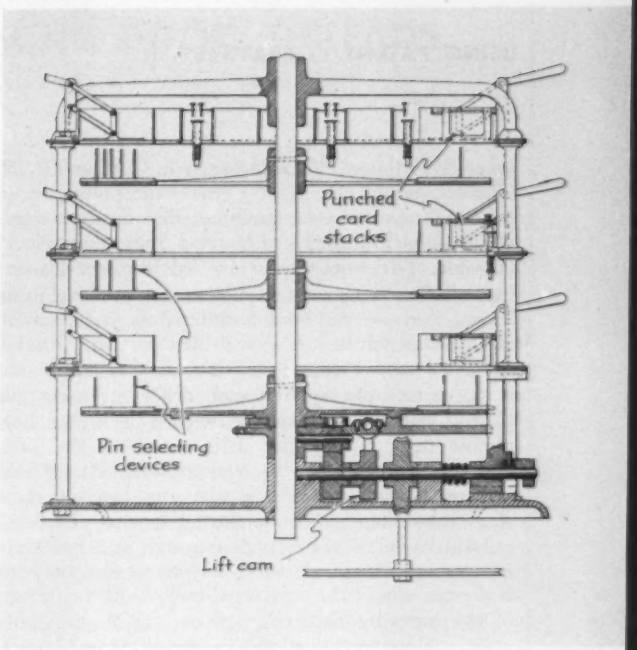


Fig. 6—Three-tier sorting apparatus for punched cards was patented in 1894 under Patent 518,240. Each tier holds 16 pin selecting devices which are successively indexed under 16 stacks of punched cards. After each index, the selecting devices are lifted by a cam against the bottom of a card stack, and, if the pin pattern and hole pattern in the card match, the card is released to the selecting device. An alternate arrangement of the same system rotates the stacks and lowers them onto stationary pin patterns.

▶ Multiple Operation Machines

A very early example of a multiple-tooled screw machine appears in Patent 27,370 issued to J. W. Lyon in 1860. This particular machine was designed to machine small brass plugs such as were used to control gas flow in gas fixtures. The plugs are held in a chuck by their oversized thumb heads, and the following operations are performed: 1. Cut a shoulder or washer seat on the end of the plug, slightly undercutting it. 2. Drill and countersink a hole for a washer screw in the end of the plug. 3. Tap washer screw hole. 4. Turn the sides of the plug to a regular taper. 5. Cut a flat on one or opposite sides of the plug to receive either a D or O-shaped washer.

This machine is operator controlled by a system of hand and foot levers to bring the various tools into play. It contains adjustable tool stops so that skill is necessary only to set up the first plug, and then any number of plugs of the same size can be made with a minimum of skill. One innovation included in this machine is a friction held tap tool that can slip in its holder once it has cut to depth so as to prevent damage to the tapped threads or to prevent breakage of the tap.

The patent class on boring and drilling covers many early patents, and one of the most interesting

found was Patent 172,622 issued in 1876 to G. W. Glazier and O. E. Wait. This patent describes a belt-driven automated machine, *Fig.* 5, that is capable of machining thread bobbins from square blocks of wood. The wood blocks are fed from a magazine into a hollow auger where they are cut to dowel form. Then, they are fed and positioned in a six-station vertical dial where a hole is drilled partially through the block and a chisel squares one end, a saw cuts a slot across the squared end, drills on either side of the bobbin simultaneously drill a center hole almost through, another drill completes the hole, and a reamer finishes the center hole. The bobbin is then pushed out of the dial and inserted on a four-station horizontally indexing fixture where the outside barrel of the bobbin is rough and finish cut in two operations. Final operation of the machine is the ejection of the completed bobbin off the spindle of the indexing fixture.

In a class for classifying, separating, and assorting solids, a subclass was found for "perforated article automatic assorting" which contains some of the punched card patents for data processing machines. One of these patents dates back to 1894 and was issued to J. K. Gore under Patent 518,240. This patent, *Fig.* 6, describes an apparatus for sorting punched cards and compiling statistics. The machine consists of a three-level sorting tier having 16 card stations on each tier. Underneath each tier are 16 rotating selecting devices which hold pin patterns set up to enter the desired punches in the punched cards. The selecting devices are intermittently indexed under stacks of cards in the card stations and are lifted up against the bottoms of the stacks. If the punched holes in the bottom card match the pattern of the selecting pins, the card is released onto the pins. If the holes do not match, no release occurs, and the device is indexed to the next station.

Another subclass deals with automatic weighing and assorting machines and includes Patent 185,858. Issued in 1877 to J. H. Gill, the patent describes a weighing machine which checks cartridges against a standard and then deposits them in two separate piles at two ejection stations. One pile is for cartridges which weigh the correct amount, and the other is for underweight cartridges. This machine, *Fig.* 7, consists of a dial having six weighing stations. In each station is a counterbalanced fixture which holds one cartridge. After the fixture rides off a stationary cam, the fixture changes position according to the weight of the cartridge under test. If the cartridge is of normal weight, the fixture drops the cartridge holder approximately level, and a tang under the holder rides under a trip wire and dumps the cartridge into a good cartridge pile. If the cartridge is underweight, the fixture does not drop as much, missing the first trip wire, and the tang rides under a second trip wire for bad cartridges.

Storehouse of Information

As shown in the foregoing examples, patent literature can be interesting and can contain many ideas to solve a multitude of problems. It also can contain some entertaining ideas such as the automatic hen house that confines a hen inside until she lays an egg. Many great inventions have been evolutionary in nature with successive generations of men adding to the development until the last man in the chain perfects the practical embodiment of the idea. The patent literature now existing forms a great storehouse of information upon which future breakthroughs in technological development may be based. By using this literature advantageously, much time and duplication of effort can be saved.

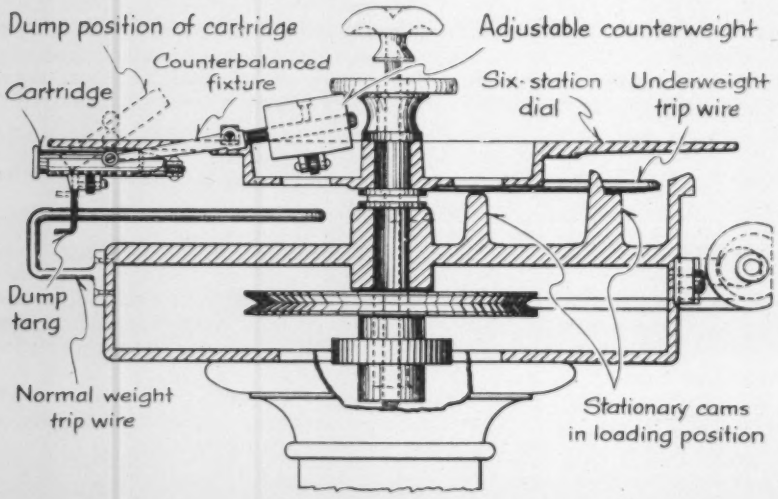


Fig. 7—Patent 185,858 issued in 1877 describes a six-station weighing machine for sorting underweight cartridges from normal cartridges. The cartridge fixture rests on two stationary cams while the test cartridge is loaded. As the dial rotates, the fixture rides off the cams and assumes a balanced position, depending upon the weight of the cartridge. Normal cartridges drop to the position shown, and a dump tang below the fixture engages a trip wire to empty the cartridge from the device. Underweight cartridges do not drop as low, and their fixture tangs engage a higher trip wire to dump them into a second pile.

CUTTING AND TRIMMING BOOK THREADS

TYPICALLY, books are sewn on automatic equipment and then moved on a conveyor past a subsequent station where glue is applied to ensure firm bindings. Before the glue is applied to the sewn books, however, it is necessary to sever a thread that interconnects each pair of succeeding books on the conveyor. This is necessary so that the books can be stacked later. Usually, this thread is cut manually in two places (close to each book) so that unsightly thread ends will not protrude from or be glued into the books. To maintain book quality, a separate operation may be set up where each book is inspected for loose or glued-in thread ends, or tails, and the books containing such defects are repaired.

Recognizing the relative inefficiency and high cost of these manual cutting, inspection, and repair operations, Automation Associates Inc. decided that a device was needed by the bookbinding trade which could perform thread cutting and trimming operations automatically. This device would be placed in the line between the book sewing machine and the gluing rolls on the conveyor. Specifications for such a device were relatively stringent, and included failproof cutting of the threads close to the books and ready adaptability of the device to any size or thickness of book handled by the sewing equipment. In addition, the cutting operation had to be synchronized with the movement of books on the conveyor so that the books would not be damaged or destroyed by the cutting blade.

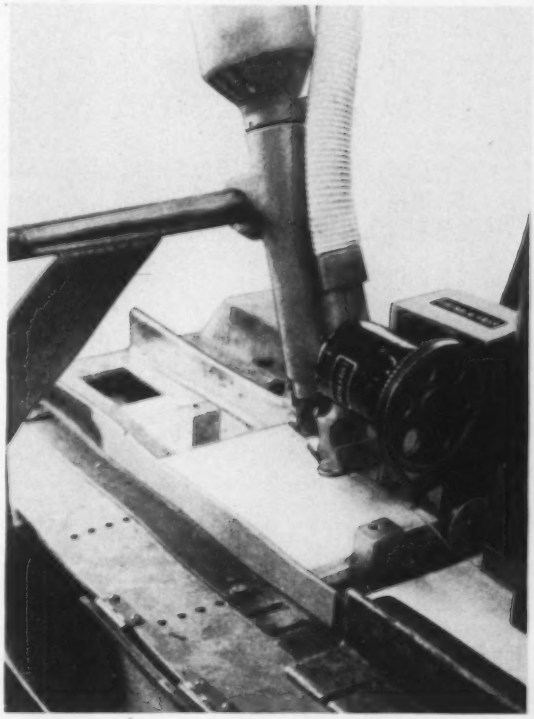
In the design phase of the project, the problem was divided into "cutting" and "trimming" requirements. This approach led to the development of Trim-A-Part, a patent-pending device for performing both of these functions automatically.

The cutting mechanism includes a circular blade that rotates at high speed. Mounted on the free end of a swing arm, the blade is driven by a motor and belt system. The swing arm is held in its normally retracted position by spring force, but it can be moved into the thread cutting position by a solenoid acting on a knocker bar.

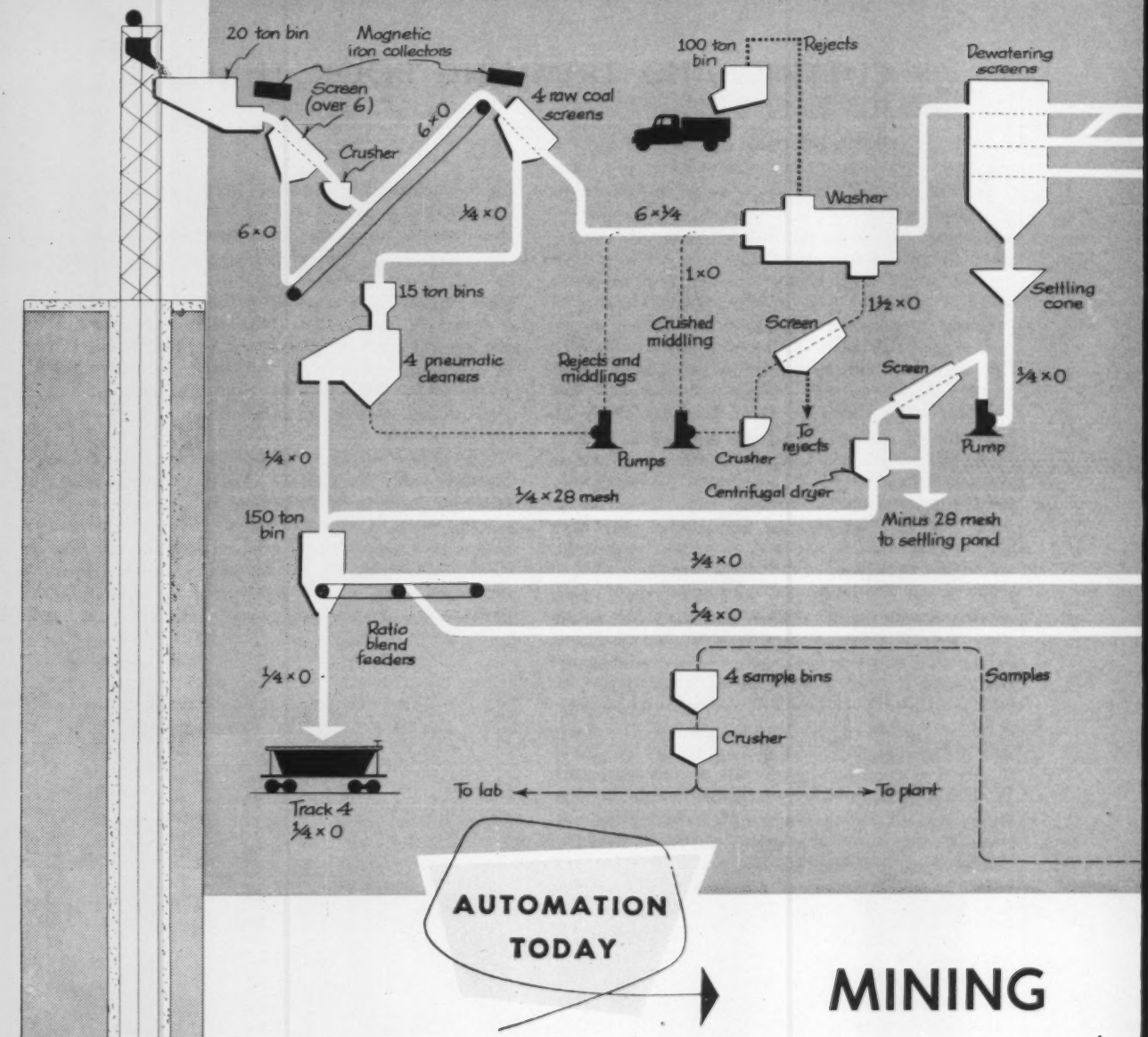
As the leading edge of a book reaches the forward end of the cutting area, the book passes over a limit switch mounted below a guide rail. This causes the book to depress the leaf of the limit switch and actuate an electrical circuit. Then, when the trailing edge of the book passes over the switch, a single electrical pulse of short duration will be impressed on the solenoid. This draws the armature into the coil of the solenoid and, through a linkage, operates the knocker bar to advance the swing arm and move the cutter blade against the thread. A complete thread cutting cycle occurs in less than one second.

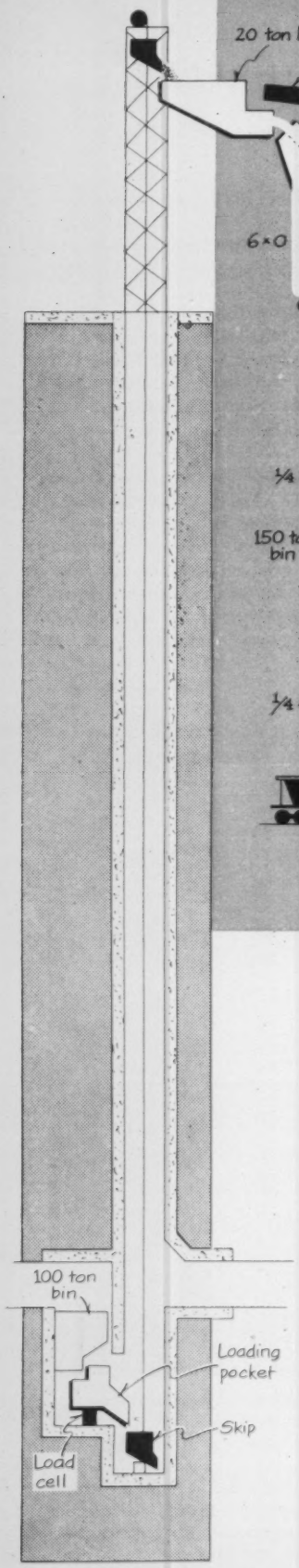
Trimming is accomplished by a unit placed over the conveyor immediately beyond the cutting station. The trimming unit includes a pair of shearing blades that reciprocate horizontally below a vacuum hood. As the end of a book passes under the vacuum hood, the loose thread is drawn upward between the shearing blades and cut off close to the book. The severed portion of the thread is then carried by a duct from the vacuum hood to a collecting tank. The entire trimming head, including the cutting blades and vacuum hood, can be adjusted vertically to suit books having different heights. This permits close trimming of the loose thread ends on all books handled by the sewing equipment.

The thread cutting and trimming device can be installed easily in available space on existing book sewing machines. Maintenance is low, usually involving only occasional cleaning of the trimming blades and emptying of the collecting tank. The cutting blade requires no sharpening because of its high speed of rotation and the force exerted on the thread when the swing arm is actuated.



Automatic thread cutting and trimming attachment for book sewing equipment includes two major units. Sewn books move to left on conveyor and pass first unit where the thread interconnecting successive books is severed by a circular blade on a swing arm. In second unit, loose thread ends are drawn upward by vacuum and cut off close to books by horizontally reciprocating blades. Severed thread ends are carried through flexible duct to a collecting tank.



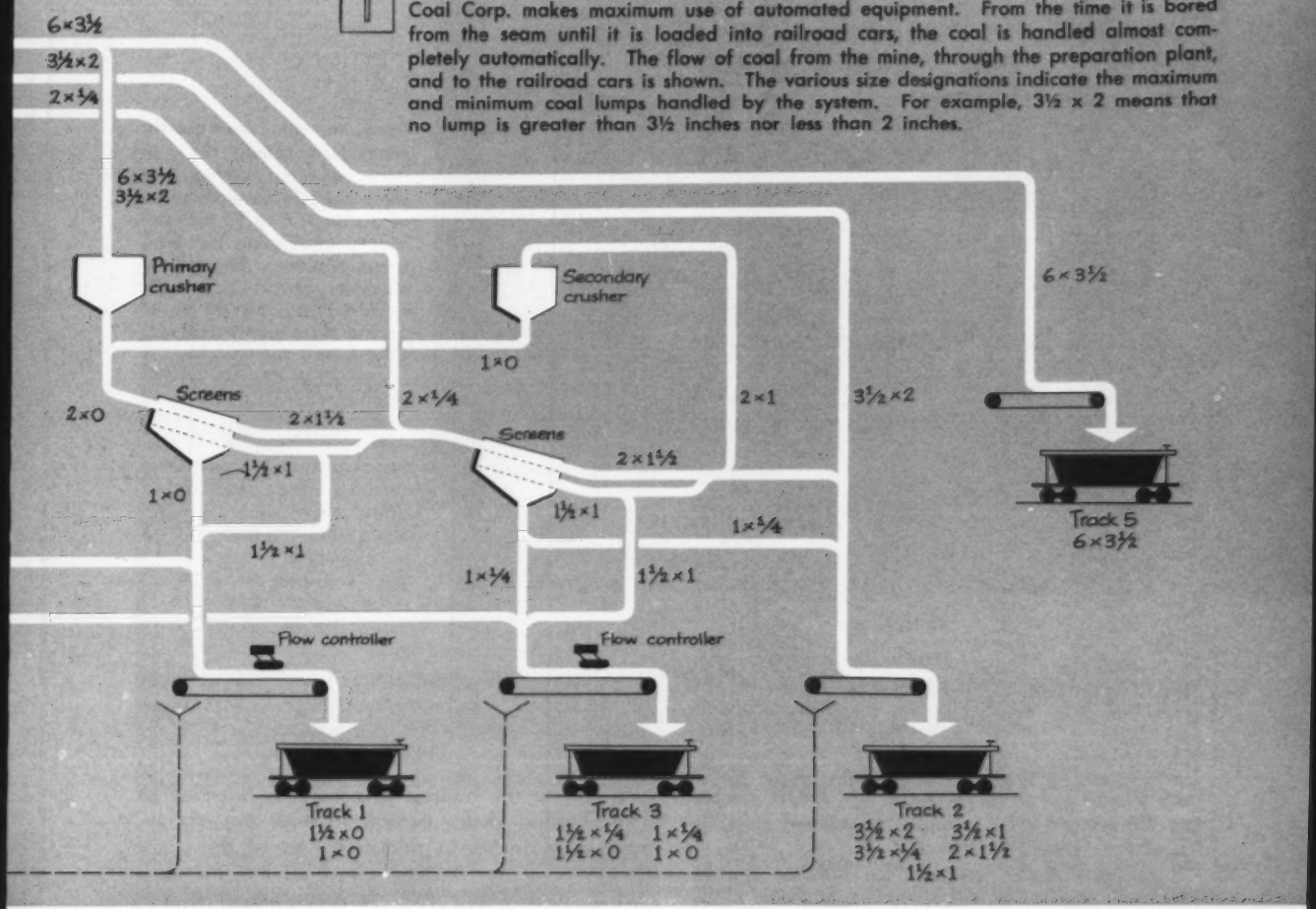


AUTOMATION TODAY

MINING

HISTORICALLY, the steel industry has always located closer to the source of coking fuel than to the source of ore. This factor led to the growth of Pittsburgh as a great steel center since it was located in the midst of the Appalachian coal fields. However, in the last 40 years the center of steel production has been gradually moving to the Midwest, creating an economic justification to use metallurgical coal mined closer to the mills. This has led to the development of a large metallurgical coal reserve in Franklin County, Ill., by the Old Ben Coal Corp., Chicago, Ill.

The company is the first Illinois coal producer to open a mine designed specifically to serve the metallurgical coal market in the Midwest. Known as Mine No. 21, the reserve contains about 100 million tons of recoverable coal located in a 9-foot thick seam approximately 670 feet below ground level. The coal in this reserve is a bituminous high-volatile coal with a low



1 Designed for continuous mining and processing of coal, Mine No. 21 of the Old Ben Coal Corp. makes maximum use of automated equipment. From the time it is bored from the seam until it is loaded into railroad cars, the coal is handled almost completely automatically. The flow of coal from the mine, through the preparation plant, and to the railroad cars is shown. The various size designations indicate the maximum and minimum coal lumps handled by the system. For example, 3½ x 2 means that no lump is greater than 3½ inches nor less than 2 inches.

AND PROCESSING COAL

sulfur and ash content and is well suited for metallurgical use when blended with low-volatile coal from Eastern fields.

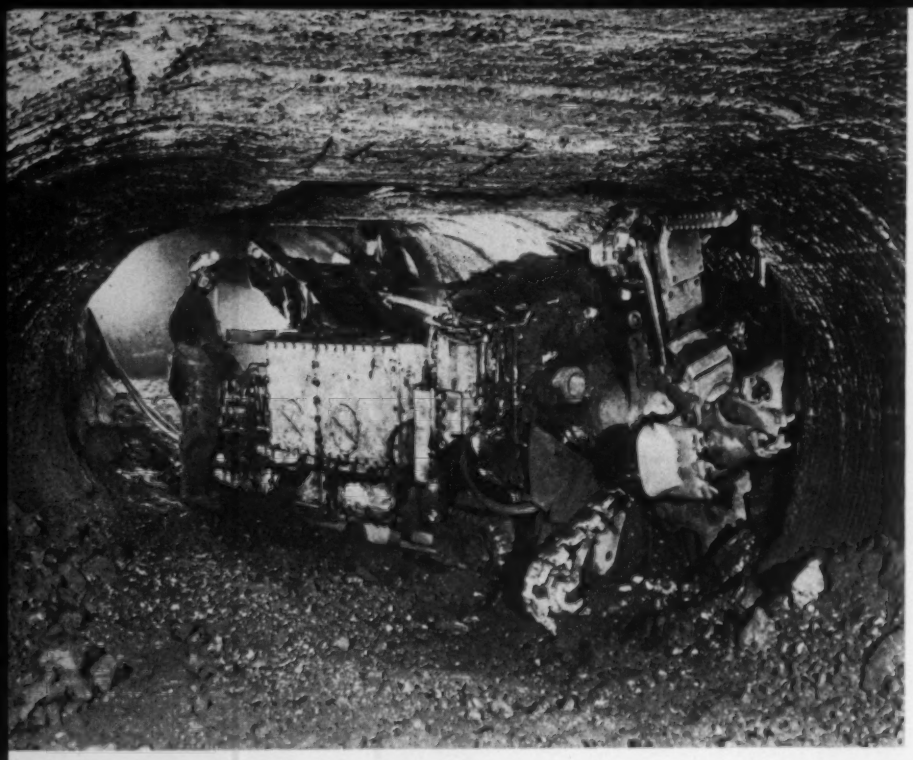
Sinking of the first shaft began in April, 1956, and the first load of coal was hoisted from the mine in January, 1960. By the end of 1962, the mine is expected to be operating at its top capacity of 15,000 tons of coal daily. At this rate, the reserve is expected to last between 30 and 40 years. A lot of this coal is expected to be shipped to steel producers in the Chicago area where approximately 18.25 million tons of coal a year are used. Since a shipping cost differential of about $1.52 per ton exists between Old Ben coal and coal shipped by rail from West Virginia, steel companies in the Chicago area can look forward to potential savings of millions of dollars annually.

Mine No. 21 is designed for continuous mining and processing of coal and utilizes automatic work performing, handling, and control equipment to a high degree. Included in this equipment are:

1. Continuous boring machines that cut a 7 x 13-foot tunnel into the solid coal seam at a rate of 8 to 10 tons of material per minute, eliminating a need for blasting.

2. An automatic coal hoist that measures out 10-ton loads of coal and hauls them from 757 feet below the surface to 45 feet above where they are dumped into a breakerhouse.

3. Fully equipped preparation plant on the surface that continuously crushes, screens, wet-washes, and dry-cleans coal to produce six main clean coal sizes. These sizes are 6 x 3½, 3½ x 2, 2 x 1½, 1½ x 1, 1 x ¼, and ¼ x 0. The



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Deep in the underground mine, twin cutting arms of this continuous boring machine cut into the coal seam at a rate of 8 to 10 tons per minute, eliminating the need for explosives. The 40-ton machine, operated by one man, leaves a smooth tunnel behind it as it moves along. Coal bored by the machine is carried to the rear of the unit by a conveyor and dumped into shuttle cars for movement to a conveyor belt. When the mine is operating at top capacity (15,000 tons daily) in 1962, eight continuous boring machines will be in operation in the various branch tunnels or entries.

equipment is interconnected by conveyor systems so that larger sizes can be recirculated in the plant to crushers and screens to produce smaller sizes to satisfy customer orders.

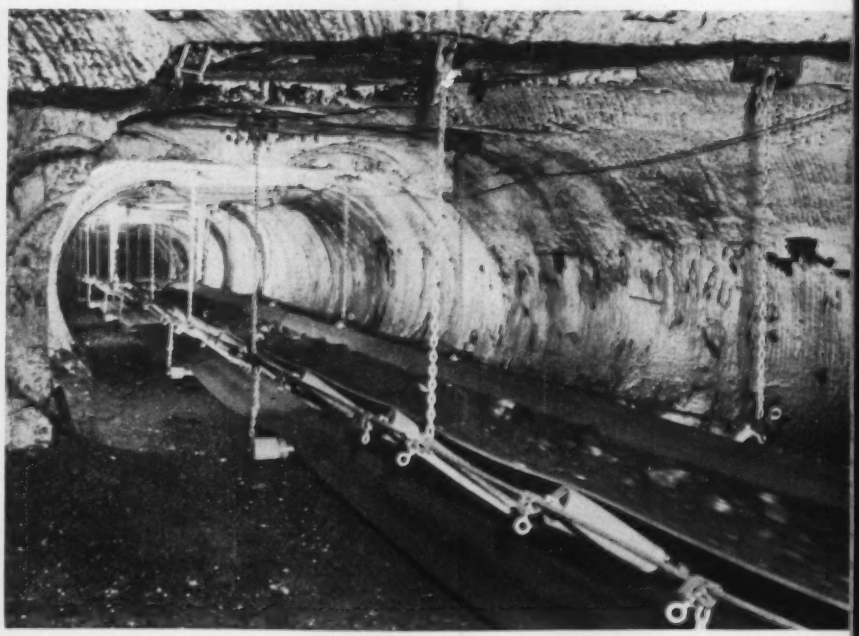
4. A system of blending conveyors that allows the six main sizes of coal to be blended in any desired combination. For example, 3½ x 1 coal can be produced by mixing 3½ x 2, 2 x 1½, and 1½ x 1 sizes.

5. Automatic loading equipment controlled by one operator that allows five railroad cars to be loaded simultaneously. An electronic recorder stamps out the net weight of coal in loaded cars on a scale while a remote television camera provides means for the weighman to note the car numbers.

Access to the underground mine is provided by two elliptical shafts, each lined with concrete averaging 16 inches in thickness. One of the shafts measures 30 feet in length and 20 feet in width and is divided into two compartments by a con-

3

Roof-suspended conveyor is used to transport the coal from the entries, where the boring machines work, to the bottom of the coal hoist, where the coal is stored until it is lifted to the surface preparation plant. This conveyor is installed in a 7 x 13-foot tunnel cut by the mining machine. The walls have been left arched to support the roof. The mining machine is followed by a twin drill roof bolter which drills a hole in the mine roof and inserts a 5-foot bolt. When the bolt is tightened, it holds the overlaying coal and rock strata firmly together, eliminating the need for timber roof supports. The white appearance of the tunnel walls is created by powdered limestone which is applied under pressure as a safety measure to minimize explosion and fire danger.



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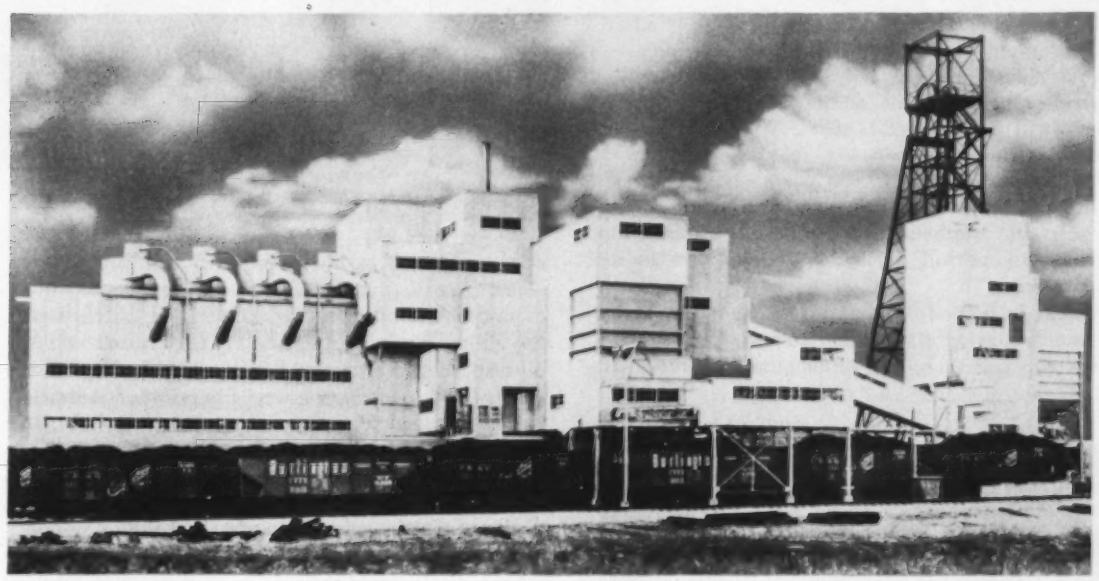
Underground, the ropebelt conveyor dumps the mined coal into a 100-ton bin. Electronic load cells govern the release of 10 tons of coal from the bin into a loading pocket. When an empty skip reaches the bottom of the hoist shaft, the loading pocket automatically discharges into the skip and initiates hoist operation. The skip is automatically lifted 802 feet to the discharge tower (right of preparation plant) in about 45 seconds by the hoist system (framework). Capacity of system is 80 skip loads per hour using two skips. Each load is automatically dumped into a 20-ton bin. Coal is fed from the bin by a reciprocating feeder to a single deck screen where lumps larger than 6 inches are separated and fed to a crusher. Lumps less than 6 inches pass through the screen and combine with the crushed coal on the sloping conveyor leading from the discharge tower into the preparation plant.



crete partition wall. A ventilating fan mounted at the top of one compartment is used to exhaust air from the mine. The other compartment is used to transport men and materials into the mine by means of a hoist and a 9½ x 12-foot cage, large enough to hold 50 men at one time. The cage will accommodate all but the largest pieces of mine equipment without dismantling. Bulky equipment, such as shuttle cars, are suspended on the underside of the cage for lowering. The cage travels at a rate of 600 feet per minute and is controlled by an operator stationed at the hoist motor in the wash house.

The other shaft into the mine measures 11 x 20 feet, is also separated into two compartments by a concrete partition, and is used to haul coal from the mine to the preparation plant. Each compartment accommodates a bottom dump skip and also serves to carry fresh air down into the mine. The bottom 90 feet of the hoist shaft is enlarged to contain a 100-ton coal storage bin and automatic skip loading equipment. Mined coal is dumped into the bin and then fed by gravity into a 10-ton loading pocket which weighs the coal electronically. When an empty skip reaches the bottom of the hoist shaft, the loading pocket automatically discharges its load of coal into the skip. The skip is then raised automatically, and no operator is required.

The skips are lifted by a 2200-hp motor located in a hoist house. They reach a maximum speed of 1600 feet per minute during their ascent from the bottom of the shaft to the discharge point of the tipple, about 45 feet above ground. It takes about 45 seconds to cover this distance of about 802 feet, and the system has a capacity of 80 skip loads per hour.

The mine is ventilated by a Joy Mfg. Co. Axivane fan with a maximum capacity of 144,000 cfm. A second fan will be installed when needed to operate in parallel with the existing fan. Each section of the mine in which a mining machine is operating will have a separate stream of fresh air with a minimum delivery of 25,000 cfm. The path of air circulation is down the hoist shaft, through the mine, and up the air compartment of the men and materials shaft.

The underground mining and coal handling equipment is shown in detail in the accompanying photographs. The continuous boring machines were built by Goodman Mfg. Co. and operate on 440-volt ac. These 40-ton machines cut an opening 7 feet high and 13 feet wide. Two 100-hp motors provide power for the twin cutting arms, and one 50-hp motor provides motive and hydraulic power. Eight boring machines will be operating when the mine is in full production. Three shuttle cars, built by National Mine Service Co., serve each boring machine and carry up to 8 tons of coal to Goodman Mfg. Co. conveyor belts for movement to the hoist shaft.

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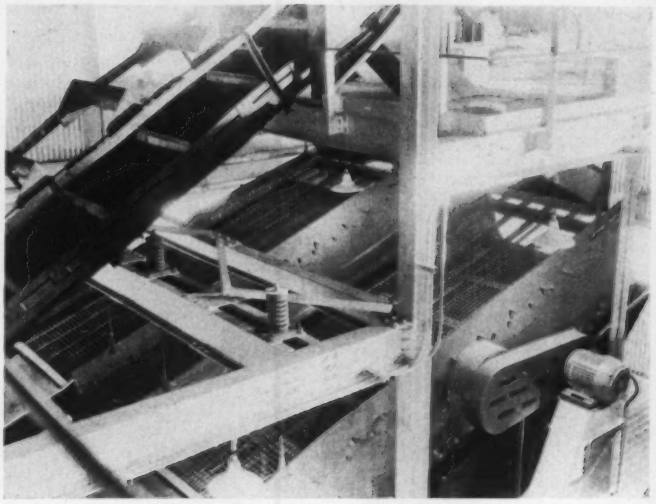


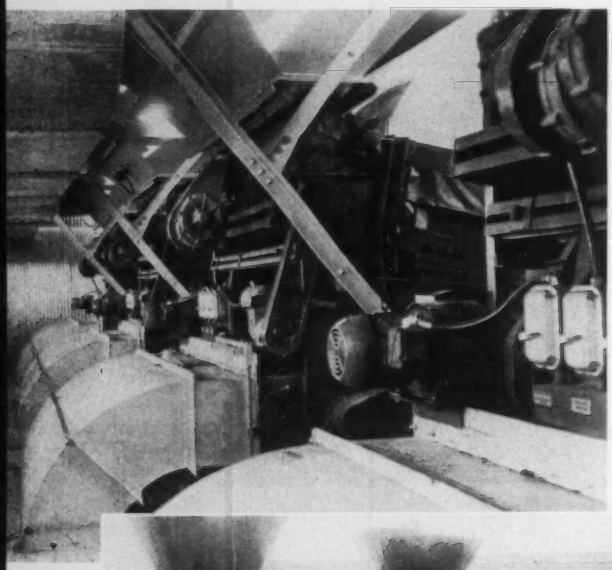
Flight conveyor in upper left of this view carries clean 2 x ¼ coal from the dewatering screens to the double-deck screens in center of picture. These vibrating screens are arranged to produce 2 x 1½ coal on the top deck, 1½ x 1 coal on the bottom deck, and minus 1 inch in the collecting hopper below screens. The output from the two screens can be conveyed to Track 2 for loading or can be diverted to the secondary crusher for further reduction. Output from the collecting hopper is conveyed to Track 3.

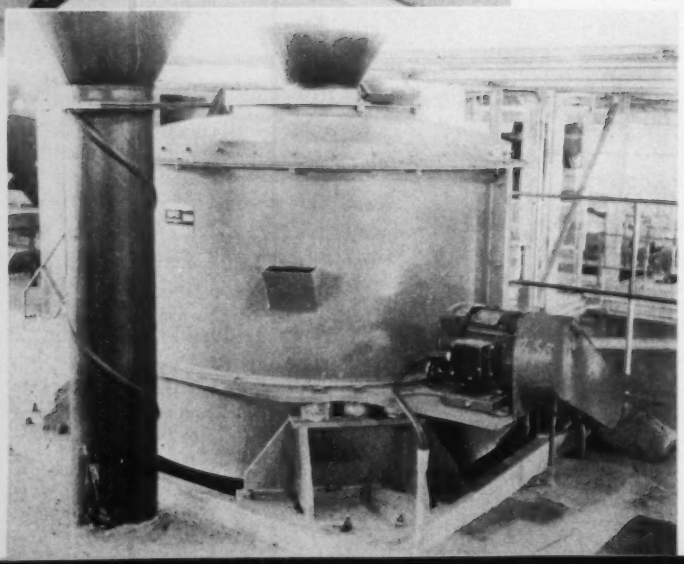
Maximum penetration of the mine corridors will be 6 miles from the hoist shaft. Total length of corridors bored by the mining machines in the reserve will be about 6000 miles. To maintain equipment during this extensive mining operation, an underground shop has been provided near the men and materials shaft. This shop will perform minor repairs and overhauls, while a central machine shop above ground will be used for major overhauls of equipment.

Coal is hoisted to the surface in either of two Connellsville Mfg. & Mine Supply Co. skips, 15 tons capacity each, and automatically dumped into a 20-ton bin. This bin is provided with an air-operated gate so that mine rock can be diverted into a rock bin for disposal by truck. Coal is fed from the 20-ton bin by a reciprocating feeder, over which is suspended a Memco Engineering & Mfg. Co. magnet for removing tramp iron, into a Hewitt-Robins Inc. single deck screen where lumps larger than 6 inches are separated and fed to a crusher. Coal less than 6 inches falls through the screen and then combines with the crushed coal on a conveyor belt leading into the preparation plant.

The preparation plant is a five-story building which was designed and built by Roberts & Schaefer Co. in co-operation with engineers of the Old Ben Coal Corp. The plant has a capacity of 800 tons per hour of raw coal input, plus 80 tons per hour available for recirculation of middlings. Flow path of the coal inside the preparation plant is shown in the diagram of the first illustration.

Some of the major equipment items in the plant are four Roberts & Schaefer pneumatic cleaners for dry-cleaning ¼ inch and smaller coal, one Bird Machine Co. centrifugal dryer for drying ¼ inch coal from the dewatering screens, two Hewitt-





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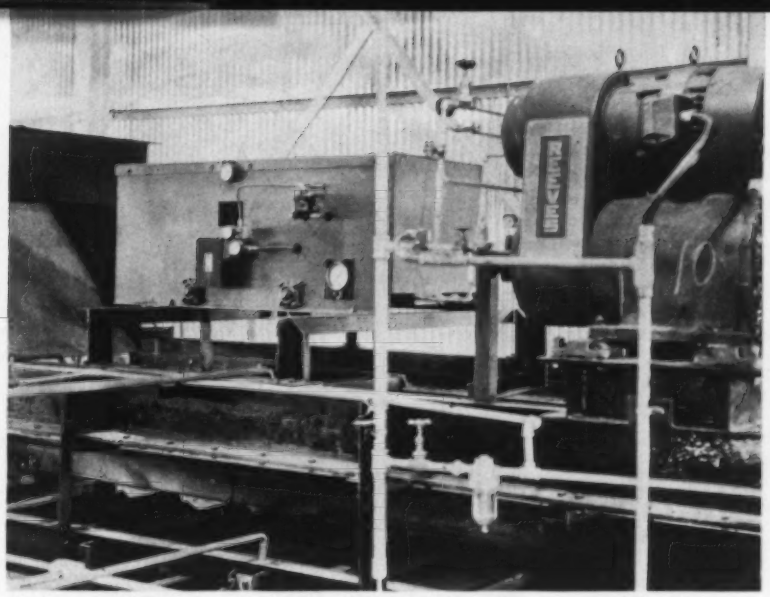
Minus ¼-inch coal is cleaned by either of two systems before being conveyed to a 150-ton bin at Track 4. Dry ¼ x 0 coal from the four raw coal screens is air washed in four units, above, and then conveyed to storage. Wet ¼ x 0 coal from the dewatering screens is collected in a settling cone, pumped over a single deck dewaterizer screen for removal of minus 28 mesh, and then dried in a centrifugal dryer, below, before being conveyed to storage.



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Ratio blend feeders control the ratio of clean ¼ x 0 coal being blended with larger sizes, at Tracks 1 and 3. These devices automatically regulate the amount of fine coal drawn from the 150-ton bin and mixed with 1½ or 1-inch coal to fill a specific order for a customer.

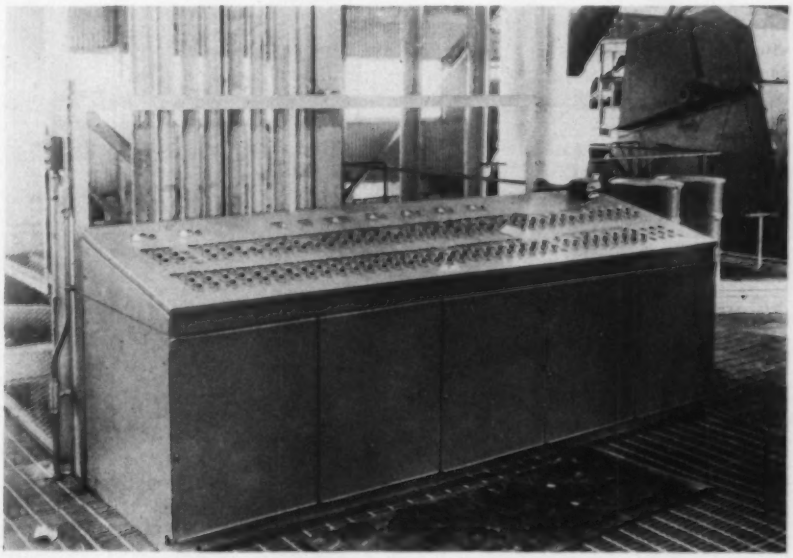
Robins triple deck dewatering screens, one Baum washer built by McNally Pittsburgh Mfg. Co. for washing coal larger than ¼ inch, eleven single and double deck vibrating screens, five crushers, seven belt conveyors, sixteen scraper conveyors, 3 bucket elevators, and five pumps.

Clean coal from the plant may be simultaneously loaded into railroad hopper cars on five tracks. On Tracks 1, 2, and 3 there are three loading points which are designated as normal position, car changing position, and locomotive bypass position. The loading operator in a cab over the tracks can select any one of these positions by pressing a pushbutton which causes all air-operated gates on feeding conveyors to shift, diverting coal to the selected position. The loading operator also controls coal sampling from these tracks. This is accomplished by pressing a pushbutton which actuates diversion gates to dispatch a sample to one of four sample bins. After a timed interval, certain gates are closed in order to eliminate contamination of coal samples.

Track 5 is serviced by a loading boom fed by a belt conveyor for only 6 x 3½ size coal. Track 4 is loaded from the bottom of a 150-ton ¼ x 0 clean coal bin by means of a chute on the bin side or from the bottom of the bin. All of the clean coal products being loaded are diverted to the proper loading positions by air-operated gates actuated by the loading operator. Weights of loaded cars are recorded electronically in the mine storeroom 600 feet distant from the scale. The remote reading scale weighs one railroad car truck at a time, computes the total, and then stamps the weight on a tape. A television camera at the scale enables the weighman in the storeroom to note the car number and record it on the tape beside the weight.

8

The coal preparation plant is operated from two control panels, the one shown is in the plant proper and a second panel is in a cab over the loading tracks. From the plant panel an operator can start all of the processing equipment and actuate gates in the various conveyor flow lines to control the movement of various coal sizes through the system. Interlocking of controls has been provided to assure proper starting order and automatic shutdown of all units if any motor stops because of overload or power failure.



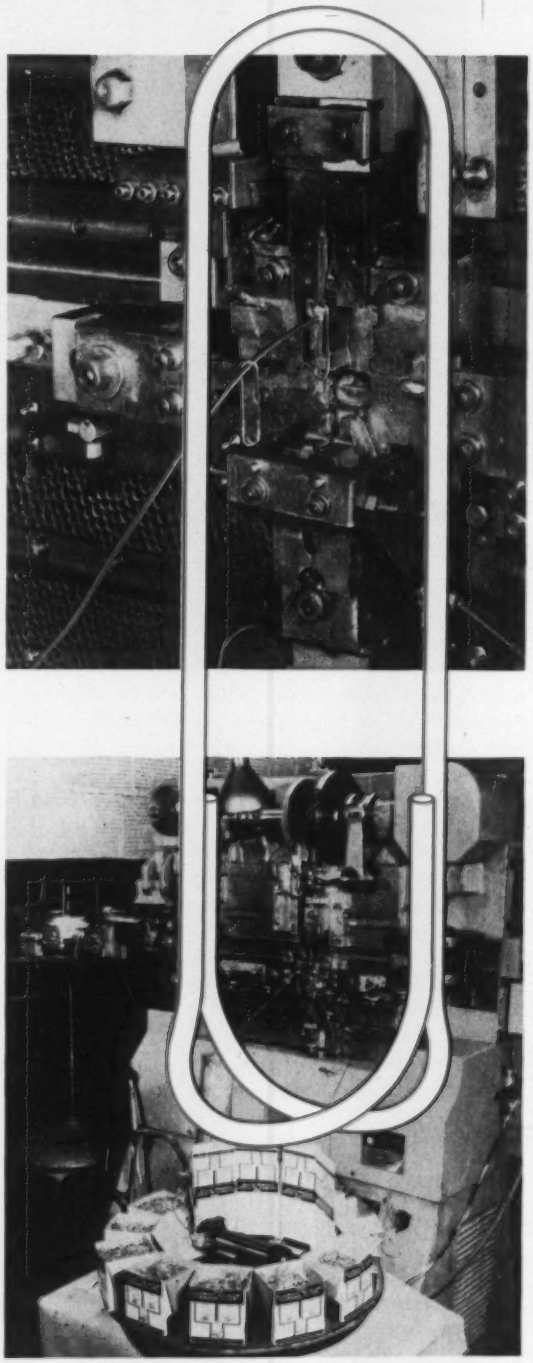


Fig. 1—Vertical four-slide machine forms hanger clips from 0.0475-inch diameter coppered steel wire at a rate of 8000 parts per hour. Wire is uncoiled, passed through straighteners, and advanced into forming area where individual pieces are cut off and formed into clips. Finished parts are ejected into cartons on indexing table. When a carton has received 1000 parts, table is indexed automatically to bring an empty carton into position. Close-up of forming area, top, shows forming tools that advance toward center form to shape parts.

MAKING PARTS FROM WIRE AND STRIP

ON VERTICAL FOUR-SLIDE MACHINES

By **ROBERT E. CARLSON**
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ECONOMIC ADVANTAGE of producing wire and strip parts on automatic equipment increases as part shapes become more complex and as output volume grows. In many cases, close dimensional control is required for such parts in order to ensure proper assembly in mechanical and electronic devices. The resulting emphasis on high quality at low unit cost has encouraged continuing development of automatic wire and strip-forming machines and of tooling methods that have the necessary combination of high output rate, precision, ruggedness, low setup cost, and flexibility.

Small wire and strip parts may be formed in various types of equipment. Examples include progressive dies, transfer presses, kick presses or single-cycle punch presses in which secondary operations are performed, and automatic four-slide machines. A progressive die outlines and forms a part in a series of stations or progressions. The last progression separates the part from the strip. In a transfer press, kick press, or single-cycle punch press, discrete parts are handled.

With a four-slide machine, a large number of forming motions can be made by one or more slide tools acting about one or more arbors or center forms. The tool motions and timing are controlled automatically by a preset cam system rather than by human operators. Thus, four-slide machines are inherently adaptable to automatic production. However, the decision to use progressive dies, presses, or four-slide machines should be based on factors such as part shape, material, quantity, dimensional tolerances, and required production rate.

A relatively recent development which has extended the capacity of four-slide machines for automatic forming is the vertical form of machine. In a

Basic production tools, four-slide machines shape parts in a variety of precise configurations from wire or strip stock. High output rates, easy changeover, and versatility of operations are characteristics of this class of machine. Some applications of vertical four-slide machines, and rules for determining feasibility of the process, are given by the author.

vertical four-slide machine, *Fig.* 1, the tools are mounted in a vertical plane to form parts about one or more center forms mounted on a rigid machine base. The center forms may be fixed or retractable. Such machines are available with various stock capacities and performance specifications from a number of machine producers. Advantages of the vertical design include accessibility and convenient height of the tooling and wire or strip.

Major Processing Steps

Four major steps can be performed automatically in a vertical four-slide machine of the type shown in *Fig.* 2, to convert wire or strip stock to finished parts:

1. **Stock Feed.** Wire or strip material is fed horizontally from a continuous coil into the four-slide machine.

2. **Press Operations.** With strip, press operations may include blanking outlines, punching, piercing, dimpling, slitting, embossing, and preforming or bending. Wire may be flattened or coined, and one or more holes may be pierced in the flattened portions on the following progression.

3. **Forming Operations.** Portions of strip or wire may be bent in multiple directions. Assembly and joining operations are also possible.

4. **Ejection.** Completed parts can be ejected automatically to tote bins, hoppers, or packages.

As many as ten separate press or forming actions may take place in the machine. In the forming area, a stock clamp usually moves downward to press the material against the top of the center form, while a cutoff die severs the individual piece for separate forming. The feed mechanism then stops. Held firmly in position by the stock clamp, the severed part is formed against the center form by the slide tools. A typical production sequence for making a part from strip is shown in *Fig.* 3.

In vertical four-slide machines, there may be more than one center form, and each may be either stationary or retractable. For example, one center form may be retracted into the vertical base during the forming cycle. This will permit additional shaping

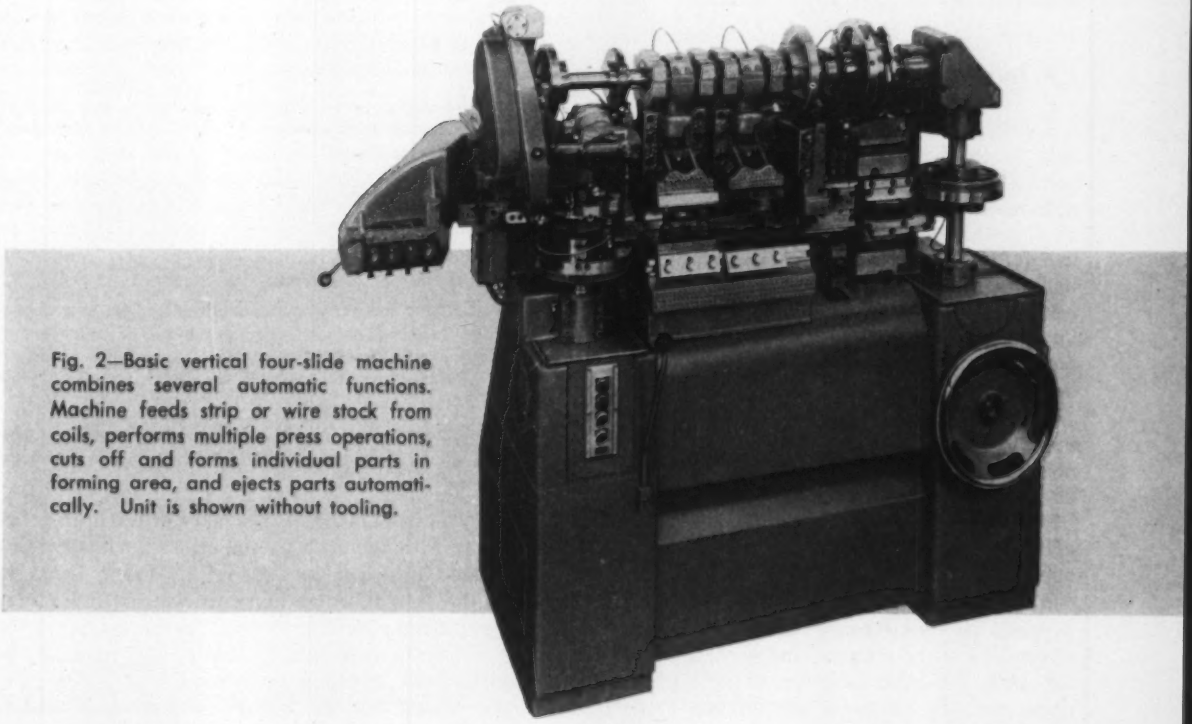


Fig. 2—Basic vertical four-slide machine combines several automatic functions. Machine feeds strip or wire stock from coils, performs multiple press operations, cuts off and forms individual parts in forming area, and ejects parts automatically. Unit is shown without tooling.

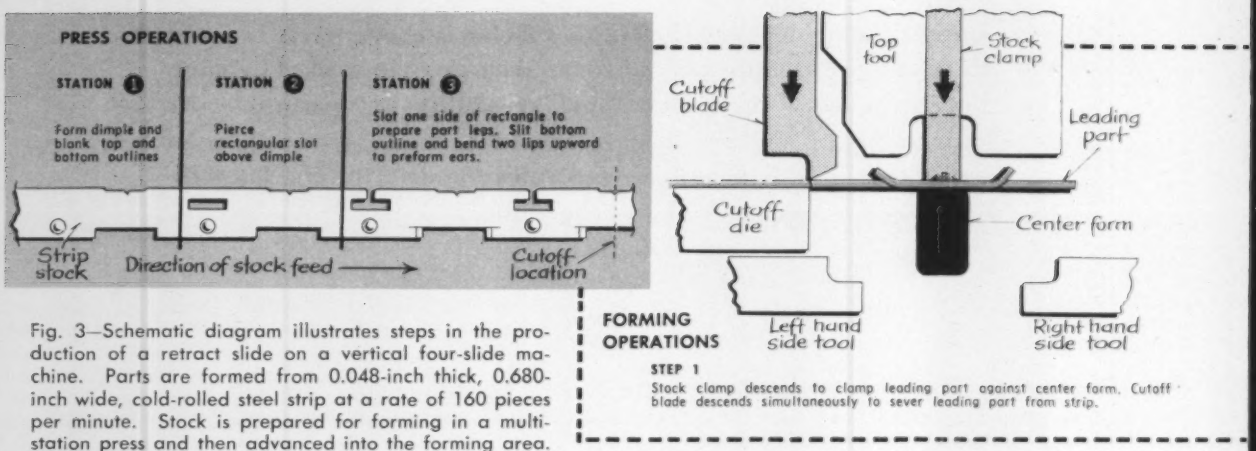

PRESS OPERATIONS
STATION 1
Form dimple and blank top and bottom outlines
STATION 2
Pierce rectangular slot above dimple
STATION 3
Slot one side of rectangle to prepare part legs. Slit bottom outline and bend two lips upward to preform ears.
Strip stock
Direction of stock feed
Cutoff location
Top tool
Stock clamp
Cutoff blade
Leading part
Cutoff die
Center form
FORMING OPERATIONS
Left hand side tool
Right hand side tool
STEP 1
Stock clamp descends to clamp leading part against center form. Cutoff blade descends simultaneously to sever leading part from strip.

Fig. 3—Schematic diagram illustrates steps in the production of a retract slide on a vertical four-slide machine. Parts are formed from 0.048-inch thick, 0.680-inch wide, cold-rolled steel strip at a rate of 160 pieces per minute. Stock is prepared for forming in a multi-station press and then advanced into the forming area. Finished parts are ejected when the center form retracts and a stripper plate moves forward.

about the other center form alone. The completed part, which is hanging on a center form, may then be ejected by an airblast, by retracting the center form into the base, or by providing a separate knock-out pin which moves out of the base to push the part off.

Bending by the slide tools in the forming area may include joining or assembling. For example, tabs or ears that have been formed in the press area may be automatically bent over, pushed through, or forced against another part of the piece to hold two sections together. In addition, welding and other combination operations may be provided after the bending motions as part of the four-slide machine's over-all production forming cycle.

Forming Cycle and Speed

A full revolution of the main cam shaft is available to feed, press, and form each wire or strip part. The performance capability of a vertical four-slide machine in that range of motion is determined, to a great extent, by the manufacturing engineer's ingenuity in tooling and timing—within the fixed limitations of the material and machine. For example, feed and forming cycles can often be overlapped and forming cycles advanced (with sufficient tool and part clearance) to fit more operations into the forming time available.

Once the details of a forming cycle have been worked out, the engineer should then determine the rate at which these cycles can be repeated in terms of parts per minute or rpm of the cam shaft. Particularly in large-volume production, it is desirable to adjust the machine to produce parts at the maximum allowable rate.

Maximum production rate of a four-slide machine depends on the forming properties and physical dimensions of the material, the strength of the forming tools, the basic structure of the four-slide machine, and the nature of the forming cycle. If the number of slide-tool actions is sufficiently small to permit conservative design of the forming cams (gradual change in cam profile, low pressure angles, short strokes), it is probable that the machine can be run at a relatively high speed with assurance of long tool life.

On the other hand, if any part of a cam system is subjected to heavy shock in the forming cycle, it may be necessary to run the machine at a lower rate in order to avoid premature tool failure. Although it is often possible to estimate the probable production speed quite accurately, it may be necessary to run the machine with the actual tooling to establish the optimum forming rate.

Production Characteristics

The most significant production characteristics of vertical four-slide machines are:

1. **Low Setup Cost.** The time required to put the machine in operation is relatively short. This is a particularly important characteristic in setting up for short runs.

2. **Versatility.** The vertical four-slide machine can economically produce a wide variety of part types in both small and large runs.

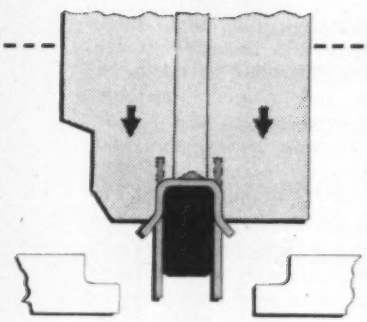
3. **Precision.** Close tolerances can be held consistently on a number of part dimensions.

4. **Combination of Operations.** Welding, tapping, thread rolling, and riveting can be performed in the press section, on the center form, or by auxiliary mechanisms acting on an extension from the forming area as the forming cycle is completed by the slide tools.

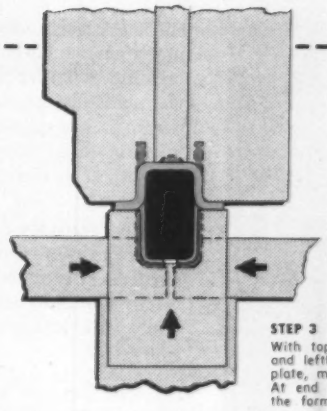
5. **Automatic Parts Handling.** Transfer systems and manual handling of completed parts can be avoided in automated production lines.

Good visibility and accessibility of the open forming area, slide-tool cams, and center form assemblies are the principal reasons for low setup costs in vertical four-slide machines. Stock is fed into the the machine at a convenient working height, so that most adjustments in the forming area can be made from a sitting position.

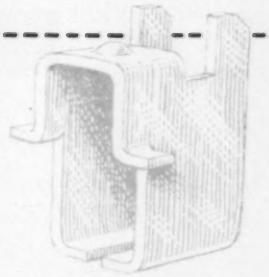
A timing disc, marked off in degrees, is used to



STEP 2
Top tool descends to bend sides downward. Legs project upward behind top tool.



STEP 3
With top tool in dwell position above center form, righthand and lefthand side tools move in to form ends. Bottom forming plate, mounted on bottom tool, moves up to finish form ears. At end of its upstroke, bottom tool bumps side tools to set the form.



establish the timing of the forming cams with respect to feed and press operations. The timing disc is set in succession at each significant camshaft angle, and the cams are locked on the shaft at the proper positions for that angle, as determined in preliminary planning. There is no need, therefore, for trial-and-error cam settings in the initial setup for a production run.

Economical production of both small and large runs means that a vertical four-slide machine can be considered a basic, flexible production tool, rather than a special purpose machine. For example, it may be called upon to produce hundreds of thousands of a single part continuously at high speeds for many months at a time, and yet be flexible enough to be shifted to a series of short runs on an assortment of wire and strip parts. Such versatility requires that the machine accept a wide variety of tooling which can be changed rapidly. A typical assortment of parts that can be made on one machine is shown in *Fig.* 4.

The forming precision of vertical four-slide machines is determined in large part both by the rigidity of the forming tools and by the accuracy of the wire or strip feed. A large center form assembly, for example, will improve strength and rigidity and thereby minimize shape variations from part to part.

The exposed position of the forming area is useful for combination operations, which require space for auxiliary equipment, and in integrating the forming operations with subsequent steps in automated production. Combination operations can be readily accomplished as the forming cycle is completed and may take place either while the part is on the center form or after it has been ejected.

In *Fig.* 5, for example, a hose clamp, formed on a vertical four-slide machine, has been pushed by a knock-out pin to the end of the center form in a position between two retractable welding electrodes. As the subsequent clamp is being shaped further back on the center form, the electrodes move to-

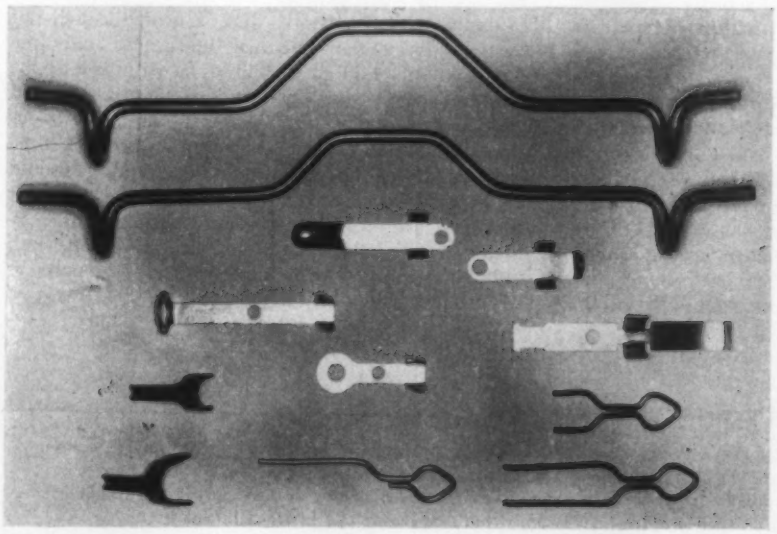


Fig. 4 — Versatility of vertical four-slide machines is illustrated by variety of parts than can be produced on a single machine. Parts shown are made from wire or strip stock and are required in widely different production quantities. Where possible, parts that are similar in shape use the same tooling details.

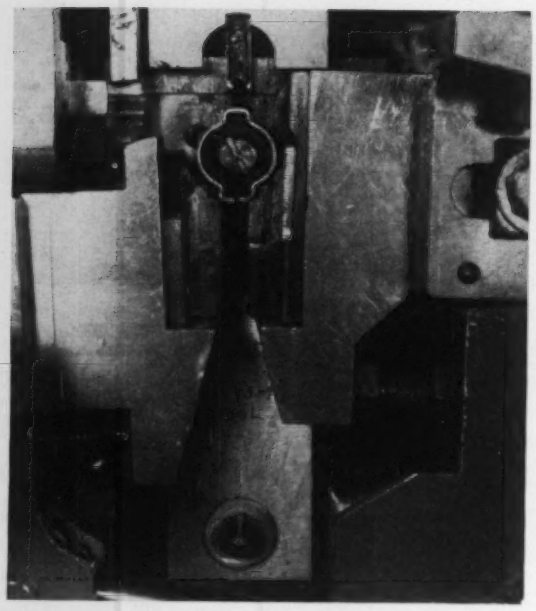


Fig. 5—Final step in production of a metal hose clamp is closing and welding of joint to form bottom lug. Clamp has been shaped in forming area of four-slide machine and pushed outward on center form by a knock-out pin. Electrodes to left and right of part will next close to effect weld. Part is ejected automatically as next part is pushed forward by knock-out pin.

gether to close and weld the joint on the bottom lug of the clamp. The welded clamp is then ejected into a tote bin when the next clamp is pushed into the welding position by the knock-out pin.

▶ Determining Feasibility

In evaluating the desirability of vertical four-slide forming for a particular wire or strip part, the manufacturing engineer should consider whether it is capable of forming the part within the specified tolerances and at the lowest possible cost.

The capacities of vertical four-slide machines available today limit the width of strip material to 2½ inches and the length of unformed pieces to 12 inches, although a machine with a length capacity of 36 inches is being developed. Limitations on the thickness of strip depend on its width, the properties of the material, and the nature of the press and forming operations. Since four-slide parts are formed on center forms, the part shapes that may be produced are limited to some degree. Because of the flexibility in tooling inherent in these machines, a careful study should be made to determine whether or not a particular part can be economically produced in this manner. In some cases, it may be advantageous to do most of the forming on a four-slide machine, leaving the final step to a secondary operation.

The economic value of four-slide forming is usually considered in terms of relative cost with respect to that of progressive press tooling. Although particular economic conditions such as overhead, wage structure, and depreciation vary from plant to plant, the following factors should be reviewed in every case.

1. **Part Size.** As part size decreases, a larger quantity is usually necessary to justify economical manufacture on a four-slide machine. Thus, 20,000 parts might be considered the minimum production run for relatively small parts. On larger parts—particularly long, unwieldy wire forms—hand operations are slower and transfer from press to press can be expensive. Smaller quantities of such pieces, say, from 5000 to 15,000 units, may be produced economically on a four-slide.

2. **Part Tolerances.** The cost of producing parts that have critical dimensional tolerances is usually lower on automatic equipment because of the smaller possibility of error in performing multiple operations. A recent trend in Europe, for example, has been to assign runs as small as 500 pieces to automatic forming machines in order to maintain product quality with unskilled labor. The additional cost of the automatic equipment and tooling is then considered small in comparison to the savings realized through low reject rates and reduced need for inspection.

3. **Elimination of Secondary Operations.** Secondary operations are usually expensive because of the costs of labor, storage and materials handling between operations, in-process inspection, and relatively high reject rates. The more times that a part must be handled during its fabrication, the more likely is the possibility that it can be produced economically on a four-slide machine.

In general, four-slide forming is economical for parts that involve a combination of blanking and multiple bends in one or more planes, or such bends alone. Simple stampings usually cannot be produced in four-slides as economically as in presses equipped with progressive dies. Uncomplicated, flat parts with regular punched holes and one-time quantities of 5000 to 25,000 parts can usually be produced at a lower cost on kick presses equipped with makeshift dies. On the other hand, if production of such parts may recur from time to time without design change, four-slide forming should be considered. The relatively low labor cost for changing over forming tools on the four-slide may then be a significant factor. For this reason, both individual lot sizes and total quantities of parts to be produced should be determined.

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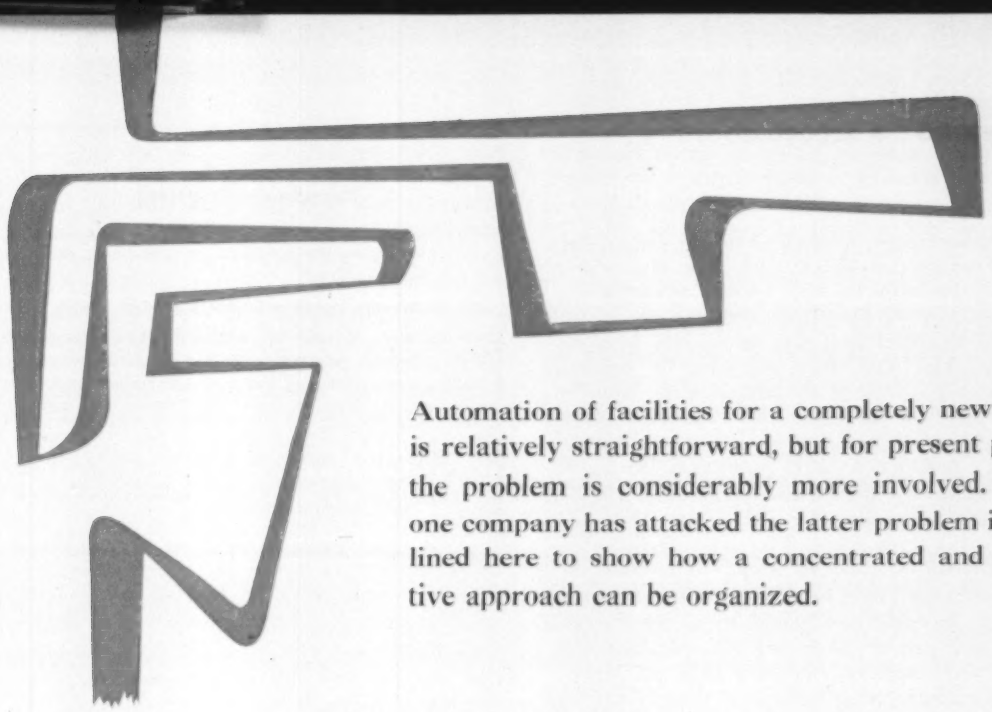

Automation of facilities for a completely new plant is relatively straightforward, but for present plants the problem is considerably more involved. How one company has attacked the latter problem is outlined here to show how a concentrated and effective approach can be organized.

ORGANIZING TO REDUCE COSTS THROUGH AUTOMATION

By **C. D. EVANS**, Assistant Manager, Manufacturing Research, International Harvester Co., Chicago, Ill.

IN ORDER to discuss the manner in which our company has organized to reduce costs through automation, it will be helpful to briefly describe the conditions as they existed in our company at the time the term automation came into being. Until 1944, our company was organized on a group basis, with all manufacturing operations reporting through various levels of manufacturing management to a vice president of manufacturing. In 1944, it was decided to divisionalize the company by product lines, with the manufacturing operations in each division reporting through a manufacturing organization to the vice president of the division.

Fortunately, our company recognized that this change in organization could result in less co-ordination of manufacturing operations than was available prior to the change. It was felt that close liaison between manufacturing operations was particularly important at that time in view of the rapid changes being made in manufacturing methods and processes. Since the beginning of World War II, the conditions of wartime economy had been conducive to vast expenditures of money directed toward research and development. This had the effect of creating technical know-how to a degree beyond anything we had formerly experienced. It was anticipated that in the years immediately following the war a real opportunity existed for all manufacturers to benefit by this change in the refining and improving of their manufacturing processes. In considera-

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

tion of these factors, we decided to take certain steps directed toward the efficient application of new processes and methods as they became available.

In the new divisionalized organization, a staff office of manufacturing was established at executive level. This staff office was given the responsibility, among others, of co-ordinating the manufacturing operations throughout the company's organization. To accomplish this, an Industrial Engineering and Construction Dept. responsible for the development of new plants, an Appropriations Review Committee responsible for the review and study of any major appropriations for plant facilities, and a Manufacturing Research Dept. were established and made responsible to the staff office of manufacturing. As might be expected, these functions had existed as a part of the former organizational structure of the company, but in a different manner.

Since manufacturing research is directly involved in the development and evaluation of automated processes and equipment, a short description of its functions may be in order. Work in the area of manufacturing research had previously been done in the operating plants of the company. In establishing a central laboratory facility, it was stated that its efforts were to augment rather than supplant any of the work being done at operating level. The functions of this new department were listed as follows:

1. To study and conduct research in manufacturing methods, techniques, processes, and new materials.

2. To develop manufacturing standards.

3. To keep abreast of technical developments through contact with technical societies, universities and colleges, public and technical libraries, and other industries and laboratories.

4. To conduct manufacturing operations research directed toward improvement in the organization of manufacturing activities.

In order to fulfill these functions, the Manufacturing Research Dept. was assigned specific objectives of furthering the development of standardization of new manufacturing methods, processes, and materials; the improvement of product quality; the analysis of production difficulties; the reduction of operating, maintenance, and product costs; and the collection and distribution of technical information to appropriate company operations. Assistance to manufacturing plants in specific cases may be provided through the initiation of a research project or through consultation and advisory service. Consultation services may be obtained for not only the development or selection of new processes and equipment, but also for assistance in setting up and placing into operation new facilities. While the services of the Manufacturing Research Dept. are intended primarily for manufacturing operations, they are also available to any other company operations or departments.

Manufacturing Research Department Functions

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- Develop manufacturing standards.
- Keep abreast of technical developments through contact with technical societies, universities and colleges, public and technical libraries, and other industries and laboratories.
- Conduct operations research directed toward improvement in the organization of manufacturing activities.

In addition to these departments, the staff office of manufacturing also has other formal means of communication directed toward the exchange of technical information. These include a Manufacturing and Research Council, which is chaired by the staff office of manufacturing. This council has membership including the executive responsible for manufacturing in each division and concerns itself with all types of manufacturing problems. Under the general supervision of this council, a group of technical committees has been formed to consider such functions as mechanical engineering, plant engineering, metallurgy, welding, forging, quality control, and materials handling. These committees assist in developing manufacturing standards for use throughout the company and provide a means of technical liaison in their respective fields of interest.

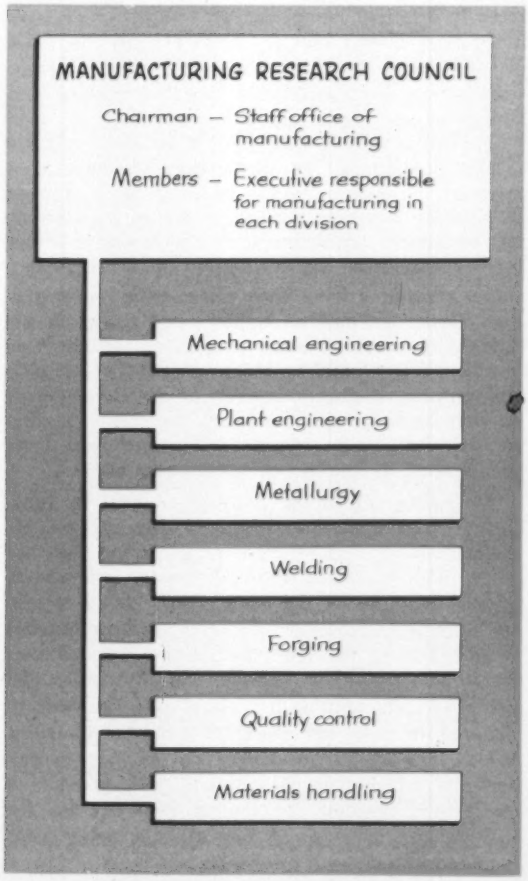
This, then, was generally the situation at the time we started to hear a great deal about automation and what it could mean from the standpoint of cost and quality. As a large diversified corporation, the problems involved in evaluating the potential use of automation were considerably more complex than would be the case in a single plant operation. In addition to extensive foreign operations, we had more than fifteen plants throughout the United States producing twine, steel, motor trucks, scrapers, crawler tractors, farm tractors, and farm implements. Not only were widely varying manufacturing processes used in the production of these products but, to complicate the situation, production schedules for individual parts varied from a few per year to 5000 a day. Also, many of these plants were old, and the facilities were not suitable for direct conversion to the new ideas of automation. By comparison, the application of automation for a completely new plant designed for volume production would be relatively straightforward. However, in our case, it was extremely complex.

As might be expected, our plant people became extremely interested in all of these new develop-

ments related to automation and quickly found that some of the ideas could be adopted easily and others only with great difficulty. It was during this period of time that we gave a great deal of consideration to the manner in which our company should assign itself to the task of making proper use of these new types of facilities. As we saw it, to have an organized approach to the problem, there were certain major areas which should be explored and resolved. These included the economics involved, the implications of product design, the adequacy of our technical organization, the requirements of training personnel, and the need for additional channels of communication.

These major areas related to the application of advanced manufacturing techniques were a subject of continuing study by the management of staff and operating units alike. It was apparent that the benefits to be obtained through their utilization were such that it was imperative we take full advantage of them. At the same time it was recognized that the degree to which these techniques should be applied depended upon many factors, such as the production requirements and the stability of design.

This made it essential that each application be carefully evaluated. In some instances, it might be of benefit to use simplified handling equipment or controls on a single machine. In other cases, complete automation of a group of machines, or even an entire line, might be justified. Due to the diversity of our manufacturing operations as compared to those of the automobile industry, the problems involved in the selection of facilities would be more complex than would be the case in a high volume production industry. Because of this fact, it was felt that our greatest potential benefits would be obtained through the use of partial automation or the utilization of versatile handling equipment on single operations or groups of operations. Another factor considered was the influence of major changes in product design on the facilities provided.

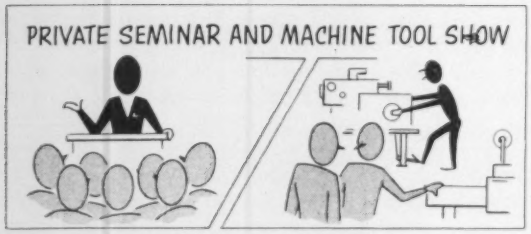


New processes and techniques can obsolete methods of manufacture almost as quickly as product design changes. Industry will invariably take advantage of new processes or equipment which show economy or an improvement in quality. Whether our company or a competitor is first to recognize the potential of new methods, we are eventually faced with new investment and obsolescence or replacement of equipment.

Coupled with this, there is always the problem of personnel. Who is going to apply and maintain the new processes? We are all acquainted with the shortage of qualified engineers and the growing shortage of men in the skilled trades. This is not only due to the number of individuals specializing in these fields but also to a greater demand for their talents resulting from increased complexity of tooling and equipment. Increased application of mechanization and automation will tend to accelerate this growing shortage. Hand in hand with the problem of skilled technical help is the necessity of upgrading and training of labor to operate, set up, and maintain the more advanced equipment. To assist in answering some of these problems, our company has formal programs of training which are conducted at our manufacturing operations on a continuing basis. We also have a tuition refund plan through which any interested employee may have his tuition refunded for training he obtains through an accredited school.

Careful consideration of all these factors and others led into a study of the organizational structure which would permit us to best take advantage of the principles of automation. At that time, many companies were considering special automation departments to be responsible in this area. After studying the situation as it existed in our company, it was felt that the establishment of such a department would involve too much overlapping with the established functions of other departments.

This was probably natural, inasmuch as the organization as it existed at that time had been designed with the influx of new manufacturing processes and equipment in mind. As a result, at plant level, we already had the integrated services of departments responsible for plant engineering, mechanical engineering, planning, advanced planning



production research, and standards and methods. In addition, dependent upon the plants' specific needs, specialized personnel in the fields of foundry, forging, welding, and materials handling were available to these departments.

Accordingly, it was decided to make use of our existing organization and take whatever steps were necessary to assure that all of the departments involved were kept informed relative to the rapid progress being made in automation. As one method of accomplishing this, we decided to conduct, for the benefit of the entire organization, a seminar type of conference which we entitled "Progress Through Automation."

In 1956, the first conference of this type, complete with lectures, films, discussion, and demonstrations, was held at our Manufacturing Research Dept. In many ways, this first seminar included the same types of information covered in the manufacturing automation conferences at Purdue. In attendance were members of executive management, divisional and staff management, and operating personnel. The entire program was designed to provide everyone with the same information relative to our company's thinking in the field of automation so that we would be consistent in the concepts of its application.

Included at this first conference was what we understand was the first private machine tool show given by a major corporation for the purpose of demonstrating the most advanced processes and automation devices available on the market. Also included was detailed information concerning some of the electronic working tools of automation, such as digital and analog computers, binary system converters, and memory units. This type of conference was well received as an instrument of communication. As a result, these conference type seminars are now being held on an annual basis. Those participating, in addition to members of executive management and product engineering, include our works managers, mechanical engineers, planning engineers, and other affected works staff personnel.

During the first conference in 1956 the following information was presented by the vice president of manufacturing:

"We must base our selection of equipment on the soundest kind of judgment of present and future need. If this is done by all who are concerned with the selection of equipment, executive management will be able to make its decision in a way calculated to best serve all of the varied interests of the Company.

"In planning for these conferences, it was agreed that both Engineering and Manufacturing personnel should be invited to participate. It would be pointless for product engineers to provide plans for products designed to take full advantage of economically automated systems if the engigineers in manufacturing did not provide this type of equipment. On the contrary, it will be fruitless for the manufacturing engineers to provide the automated system if the product design and stability of design do not permit taking full advantage of the facilities provided. In this area it is essential that both the design engineers and engineers in the manufacturing departments work together toward the most effective design and facilities to provide the optimum of production."

We believe that our choice to train and use our existing technical organization, rather than to develop a new group of automation specialists, was wise. We are more convinced than ever that the differences in automation and the methods already being applied are more in definition of terms than in a radically different technical breakthrough. We have just as much respect for the automatic controls of automation as we have for mechanization, and our experience has demonstrated that there is a great reward in their logical application.

Most technical advances have generated their own peculiar problems, and automation is no exception. In reviewing our experiences, some of the problems we have encountered are particularly important. For example, the problem of converting recently acquired equipment as a result of changes in product design requires further study. In cases of unforeseen product changes, premature obsolescence involving enormous losses of tooling and equipment are extremely difficult to avoid, even with skillful management and better than average market predictions. For this reason, we have been extremely interested in the building block concept of machine tool construction as a means of avoiding equipment obsolescence in the event of either product change or the availability of new processes.

Our personnel have been active with representatives of the automotive industry and others to accelerate the developments in this area as much as possible. When building block construction for general purpose machines, similar to the development for way and transfer machines, becomes a reality, we will be able to convert production lines from one product to another at a minimum cost.

To answer all of the problems related to automation, it is imperative that any company provide a concentrated and effective program for their solution. The organized approach we have developed appears suitable to the conditions existing within our company. However, there is no easy answer to any of these problems, and it is recognized that the specific conditions in other companies may dictate a different approach. Each of us desires to protect and increase our market, to reduce our costs, and to improve our products. We feel that, to successfully accomplish these goals and preserve a competitive position, a planned program for the analysis and adoption of new manufacturing processes and techniques is imperative.

CONVEYOR-FIXTURE LINKS 8 STATIONS IN

PRODUCING HINGED ASSEMBLIES

By **S. S. AIDLIN,** President
and
S. H. AIDLIN, Vice President
Aidlin Automation Inc., Brooklyn, N. Y.

ALWAYS an important ingredient in solving production problems, ingenuity becomes the essential ingredient in automating assembly operations. Typically, this additional emphasis on inventiveness is brought about by the need for precision in handling a variety of shapes and sizes of parts. The problem can be further complicated by economic considerations that dictate that assembly equipment handle existing part designs, even though the parts were not initially conceived with automatic assembly in mind.

These aspects are highlighted in a machine created to assemble component items into a toilet seat assembly. The parts of such an assembly include a lid, seat, 7-component hinge, and four plastic bumpers. The hinge is fastened to both lid and seat by wood screws; the bumpers are pressed into predrilled holes. Aidlin Automation Inc. designed the machine.

The assembly machine includes eight workstations, arranged in-line with parts successively transferred from station to station by an endless steel slat conveyor, *Fig.* 1. Motion of the conveyor is intermittent, with advancement force provided by the rod of a pneumatic cylinder engaging dogs on the underside of the conveyor. As both the engagement point of the dogs and the stroke of the pneumatic cylinder are adjustable, the distance the conveyor moves can be changed to suit varying needs. A positive spacing of advancement is provided by a double-acting pneumatic cylinder which actuates a stop, preventing the conveyor from advancing beyond a predetermined position. This stop can be adjusted to compensate for any elasticity in the steel slat conveyor.

The problem of conveyor travel is particularly critical because the conveyor is, in effect, an endless series of orienting-clamping fixtures which hold the lids and seats during the assembly operation. Attached to the conveyor belt, each fixture consists of a fixed backstop and two spring loaded clamps (one on each side of the workpiece). The clamps are so arranged that a seat or lid is pushed against the backstop, and the clamps are so calibrated that the seat or lid is centered between the two clamps. The clamps are normally closed, being opened by the

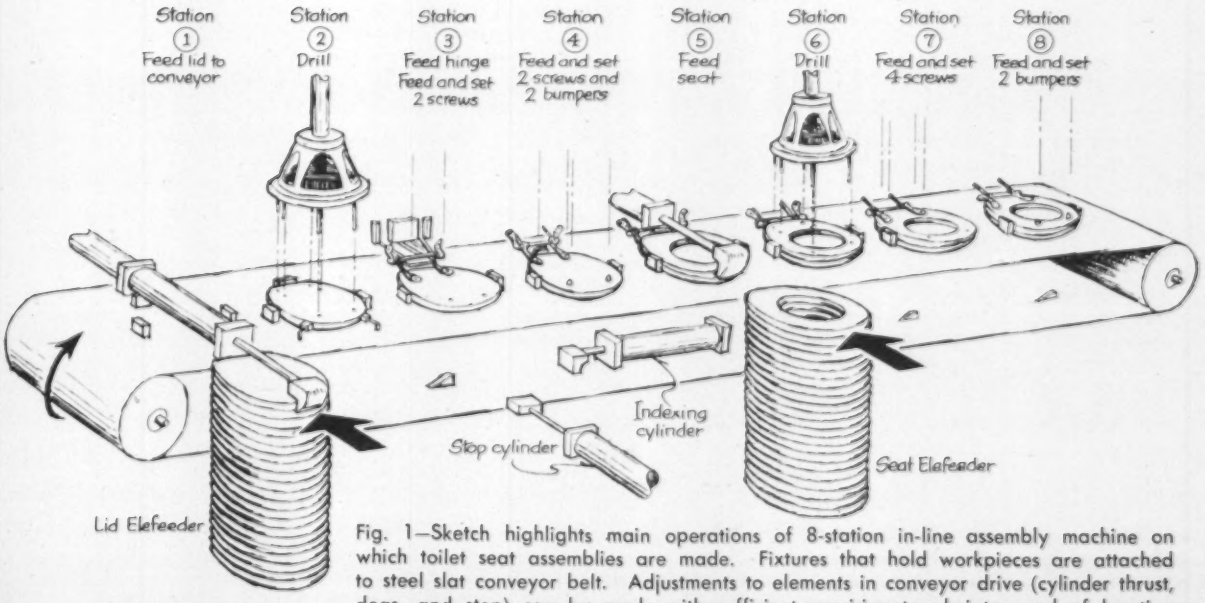


Fig. 1—Sketch highlights main operations of 8-station in-line assembly machine on which toilet seat assemblies are made. Fixtures that hold workpieces are attached to steel slat conveyor belt. Adjustments to elements in conveyor drive (cylinder thrust, dogs, and stop) can be made with sufficient precision to obviate need of locating pins at each workstation.

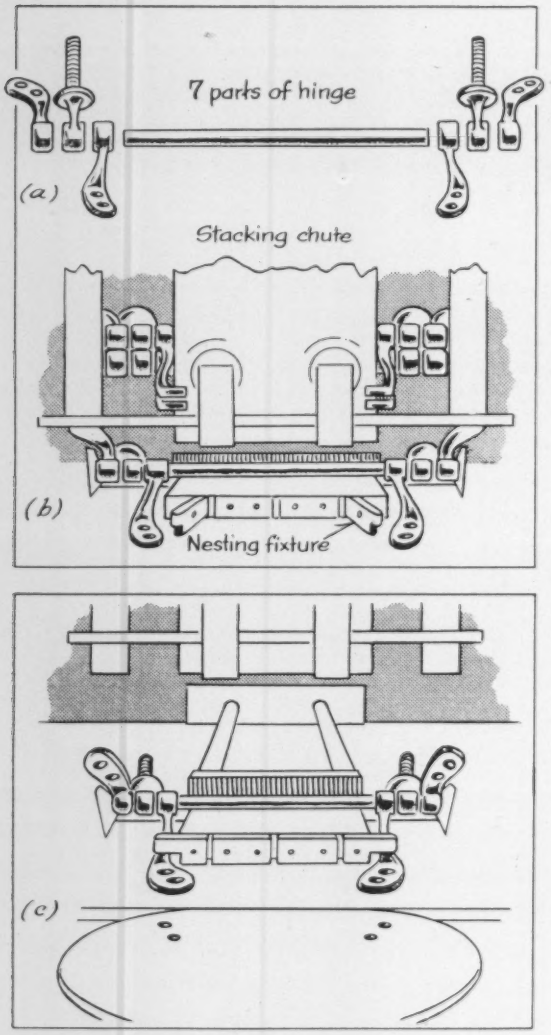


Fig. 2—Hinge, shown in *(a)*, that is applied to toilet seat assembly can literally fall apart unless members are restrained or screwed to workpiece. Parts of hinge are preassembled and placed into chute, with elements in desired positions. Assembly is maintained as hinges drop from chute onto nesting fixture, *(b)*. Hinge is automatically clamped in fixture as pneumatic cylinder operates to position hinge elements over predrilled holes in lid, *(c)*.

action of a pneumatic cylinder when a lid or seat is loaded into the fixture.

Operations performed at each of the eight workstations along the conveyor are as follows: Station 1—Lid is loaded and clamped. Station 2—Drill six holes in lid (four for woodscrews, two for plastic bumpers). Station 3—Feed and orient hinge, and feed and drive two screws. Station 4—Feed two bumpers, press into drilled holes, and drive two screws to complete attachment of hinge to lid. Station 5—Seat is loaded and clamped. Station 6—Drill six holes in seat (four for woodscrews, two for plastic bumpers). Station 7—Feed and drive four screws to complete attachment of hinge to seat. Station 8—Feed two bumpers and press into drilled holes.

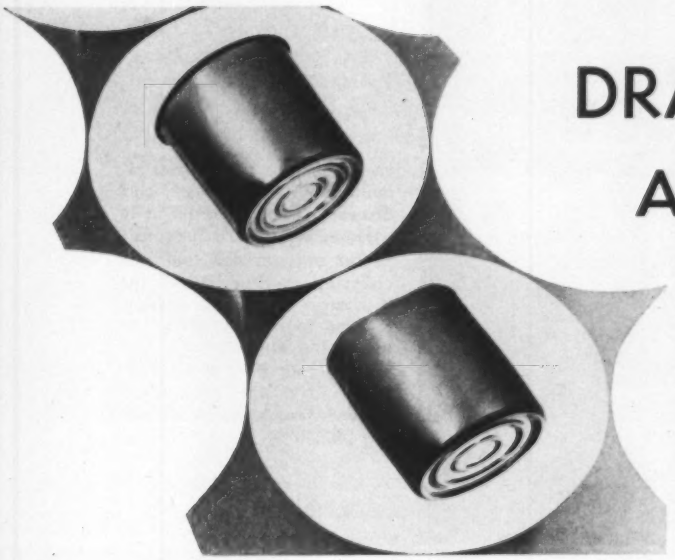
At both Stations 1 and 5 where lids and seats are loaded, the workpieces are stacked in special elevator-feeders. There are two such caster mounted devices at each station, and while one is in use, the other is being loaded. By means of counterweights and springs, the elevator-feeder indexes the stack of workpieces upwards as individual workpieces are stripped from the top of the stack. Two pneumatic cylinders are involved in a loading operation. The actuation of one cylinder opens the spring loaded orienting-clamping fixture that is attached to the conveyor. This action is followed by the second cylinder pushing the workpiece into the fixture. Upon retraction of both cylinders, the workpiece is clamped in position.

Multispindle drill heads are used to drill the six holes at both Stations 2 and 6. The standard drilling units are reciprocated vertically by means of pneumatic cylinders. Depth of feed is controlled by limit switches which can be adjusted to vary stroke length. Several models of assemblies are handled by the machine, the models differing with respect to over-all size of parts and design of hinges to be used. These variations affect the hole pattern to be drilled in the lids and seats. To speed-up production changeovers, templates are used to relocate the position of spindles in the multispindle drill head.

To a great extent, the quality of the finished assembly depends on the accuracy of the placement and fastening of the hinge to the lid at Station 3. The metal hinges are made of 7 component parts which become an assembly, in the sense that the parts cannot be separated, only after the ears of the hinges are fastened to the lid and seat. Until fastening occurs, a hinge "assembly" can fall apart.

To obtain automatic feeding of such loose assemblies (and accommodate different sizes of hinges), preassembled hinges are stacked in an adjustable sized chute. The hinge feeder is similar in principle to a bar stack feeder in that, successively, the lowermost hinge in the stack is removed from the chute. In the chute and during escapement and placement, the hinge must "flow" without falling apart and without the component parts sliding along the pin or center bar. How this is accomplished is shown in *Fig.* 2. The screws for Stations 3, 4, and 7 are fed into the collets by hopper feeders. Specially designed clutch attachments, which can convert a drill-press into a single or multispindle screwdriver, are used because of space problems and the hardness of material in which the screws are being set.

Bumpers at Stations 4 and 8 are fed by rotating bowl hopper feeders into part positioners and then pressed into the predrilled holes. With the pressing of bumpers into place at Station 8, the assembly is completed. As the conveyor indexes around its forward pulley, the holding force in the clamps is relieved and the assemblies are manually removed.



DRAWING ALUMINUM CANS FROM PRECOATED STRIP

A major drawback to making cans of aluminum has been the production cost when compared to equivalent tinplate cans. Development of new methods and automated equipment for producing cans has reduced this cost to a point where aluminum cans are competitive with tinplate cans in certain packing applications.

ALUMINUM cans are of great interest to food packers and independent can makers because of their light weight, their compatibility with most foods and beverages, and their attractive appearance. However, the cost differential between aluminum and tinplate cans has overshadowed these advantages and has retarded the use of aluminum cans. To overcome this cost differential, can makers have had to develop entirely new processes for mak-

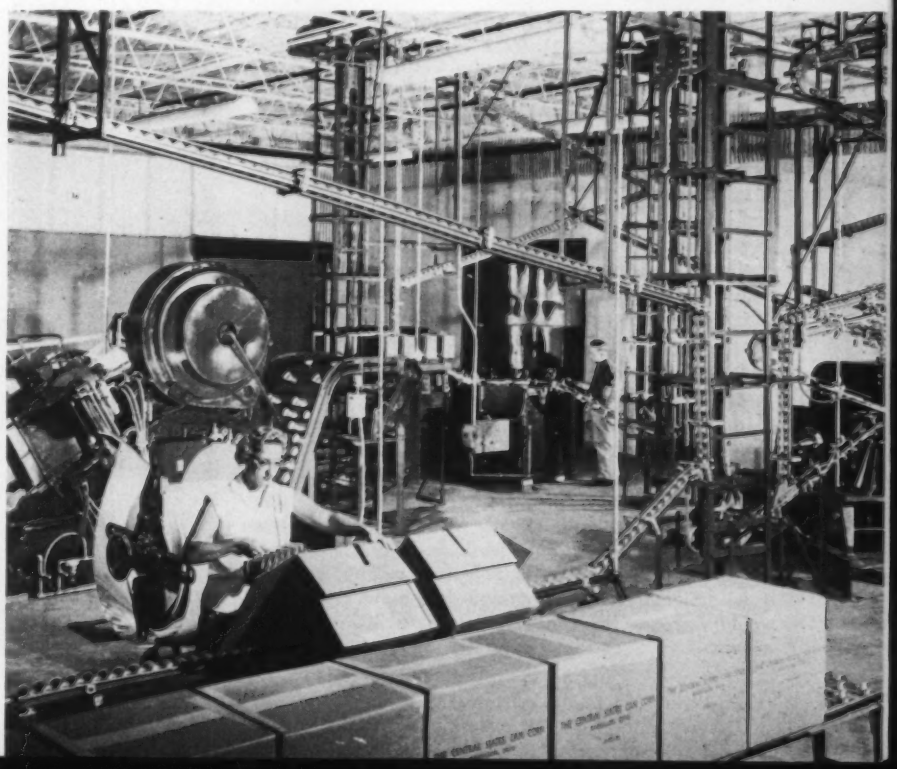


Fig. 1—Aluminum can making line at Central States Can Corp. is arranged in a U-shaped production system. Coated aluminum strip enters the inclined press, left background, and is blanked and drawn into shallow cup form. Unscrambler unit to right of press picks up cups and feeds them to an elevating unit. Cups are redrawn to final depth and diameter on press in center background and then conveyed to trimmer and flanger in right background. After flanging, cans are conveyed to packing operator in the foreground. Output of the system is 200-240 cans per minute.

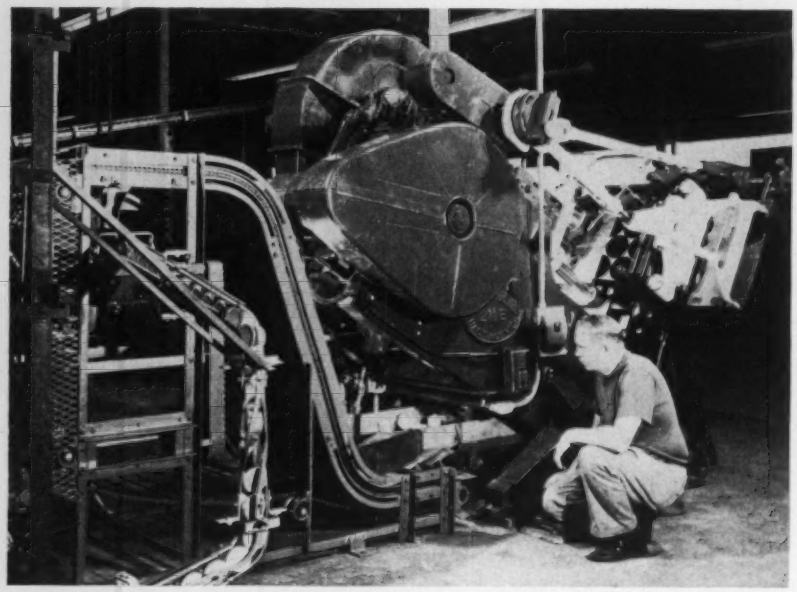


Fig. 2—Single crank press simultaneously blanks and draws three cup forms in a triple-cavity die. Cups fall to an unscrambler and are collected and oriented for discharge into can runway leading to redraw press. In all of the can runways, the cans roll by gravity on their sides. The cans are lifted between machines by elevating units.

ing cans and build integrated automated production lines for implementing the processes.

Two major methods of producing aluminum cans have been developed and installed in operating lines. The first method is based on impact-extrusion of an aluminum slug to produce a can in which the height is greater than the diameter. This type of can is being used to hold beer and can be used for other beverages such as soft drinks. The impact-extrusion process is a continuous operation from the time aluminum ingots are melted for casting into strip until finished cans with printed labels reach the filling line. Output of the impact-extrusion press is up to 120 cans per minute.

A more recent development is a method of producing aluminum cans by means of a draw and redraw process developed by the Central States Can Corp. in co-operation with the Container Machinery Div., E. W. Bliss Co., and the Kaiser Aluminum & Chemical Corp. In this process, precoated aluminum coil stock is blanked and drawn to a depth of up to one-half the can's diameter in one operation, and then, if required, redrawn to full depth in a second operation. This process is limited to producing cans whose heights are not greater than their diameters for such products as potted meats, tuna fish, and a variety of dry products.

The Central States aluminum can manufacturing line, *Fig.* 1, is designed to produce cans in three basic sizes. These sizes are $2\frac{1}{2}$ inches in diameter by $1\frac{1}{2}$ inches in height, $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches, and 3-7/16 inches by 1-13/16 inches. The equipment has the capability to produce cans up to 3-7/16 inches in diameter by $3\frac{3}{8}$ inches in height. Output of the line varies from 200 to 240 cans per minute, depending on the can size being made. Only one operator and one packer are required to run the entire line.

The automated can line is composed of the following equipment: Coil stock unreeler, Bliss single crank blank and draw press, Great Lakes Runway & Engineering Co. unscrambler, Bliss rotary redraw press, Bliss combination trimmer and flanger, and

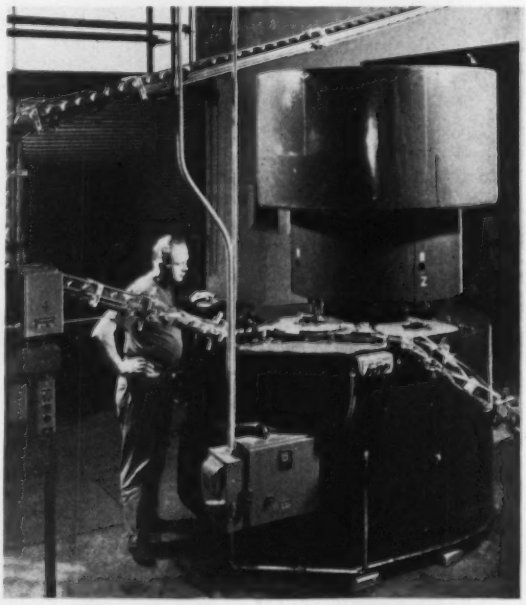


Fig. 3—Cup forms enter redraw press from the runway on the left. Horizontal star wheel escapes the cups into the lower die of the revolving turret. As the turret revolves clockwise at 50 or more rpm, the can is drawn to full depth and final diameter. Although this press is equipped with only four redraw stations, it is designed to accommodate eight stations which would increase the production rate to 400 cans per minute.

an A W Machine Co. rotary curling machine. All of the can elevating and runway conveyors interconnecting the various pieces of equipment were provided by Great Lakes Runway & Engineering Co. The runway system is designed so that the rotary redraw press and the rotary curling machine can be bypassed when the line is producing certain can sizes.

The 0.006 to 0.016-inch gage aluminum coil stock used on the can line is coated by Kaiser Aluminum and then shipped to the can manufacturer. The coating serves two purposes—it provides an interior lining for the can to prevent contamination of food products, and it provides a lubricating agent during the draw and redraw process. By coating the aluminum strip prior to making the can, the coating operation can be done at high speed on specialized equipment, and the need for cleaning, painting, and drying equipment in the can line is eliminated.

The coated coil stock feeds into a 60-ton single crank press, *Fig.* 2, mounted on permanently inclined legs. The press is tooled with a triple-cavity die and blanks and draws three cups at a time at speeds between 65 and 70 strokes per minute. The cups are discharged through the bottom of the press to an inclined unscrambler which aligns them in an open-end-up position and feeds them into a can runway leading to an elevating unit. The cups are lifted to ceiling level and discharged into a second can runway which provides a storage bank for feeding the rotary redraw press. In the case of 2½ by 1½ and 3-7/16 by 1-13/16 cans, which are both produced in a single draw on the first press, the cups can be diverted from this runway to a spur runway feeding the trimmer and flanger.

The rotary redraw press, *Fig.* 3, is a four-station rotating turret machine that operates at 50 or more revolutions per minute. Cups are escaped one-at-a-time from the can runway by a four-position star wheel and positioned over the lower die cavity. As the die turret rotates, an upper die plunger enters the cup, presses against the bottom of the cup, and causes the metal to flow into the lower die cavity. The action in both drawing presses is a flowing of metal rather than a stretching of metal, that is, the metal thickness of the drawn and redrawn can is approximately the same as the thickness of the original coil stock material.

The can is drawn to depth and diameter in less than half a revolution of the turret. During the remainder of the revolution, the upper die plunger is withdrawn, and the can is pushed from the lower die cavity by a rising center form. A second four-position star wheel picks up the can and discharges it to a can runway feeding an elevating unit. The can is again raised to ceiling level and discharged into a storage bank runway feeding the combination trimmer and flanger.

The trimmer and flanger, *Fig.* 4, is a six-spindle machine which operates at 33⅓ or more revolutions per minute. The spindles rotate as well as the turret that holds them. From an overhead storage runway, the can bodies are escaped by a star wheel and are held in position by a vacuum. The operation begins as two knives cut the can body almost to the trim line. As the turret rotates, the knives recede, and the trimming cutters rise against the body and slit off excess stock as the spindle revolves the can. As the turret continues to rotate, the body is moved forward into a flanging tool. The flanged can is then ejected into a discharge chute and raised to ceiling level by an elevating unit. This unit feeds the cans into a storage runway leading to the packing position. Cans which will be filled and sealed in the conventional way with a lock-seam top are packed in cartons and shipped to the ultimate user.

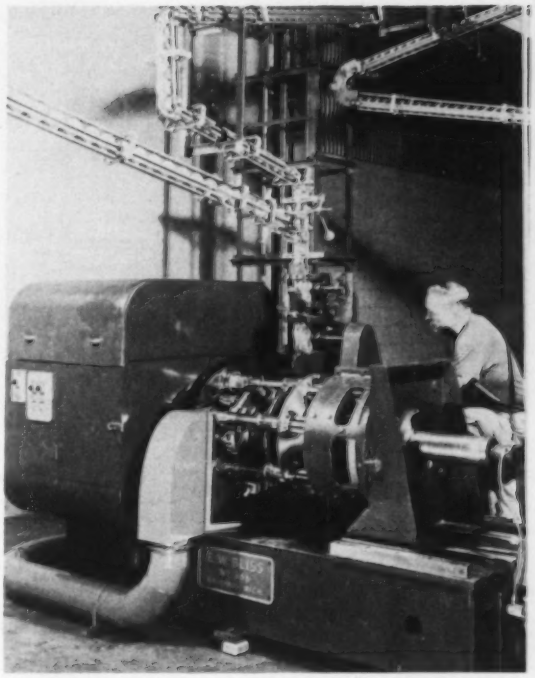
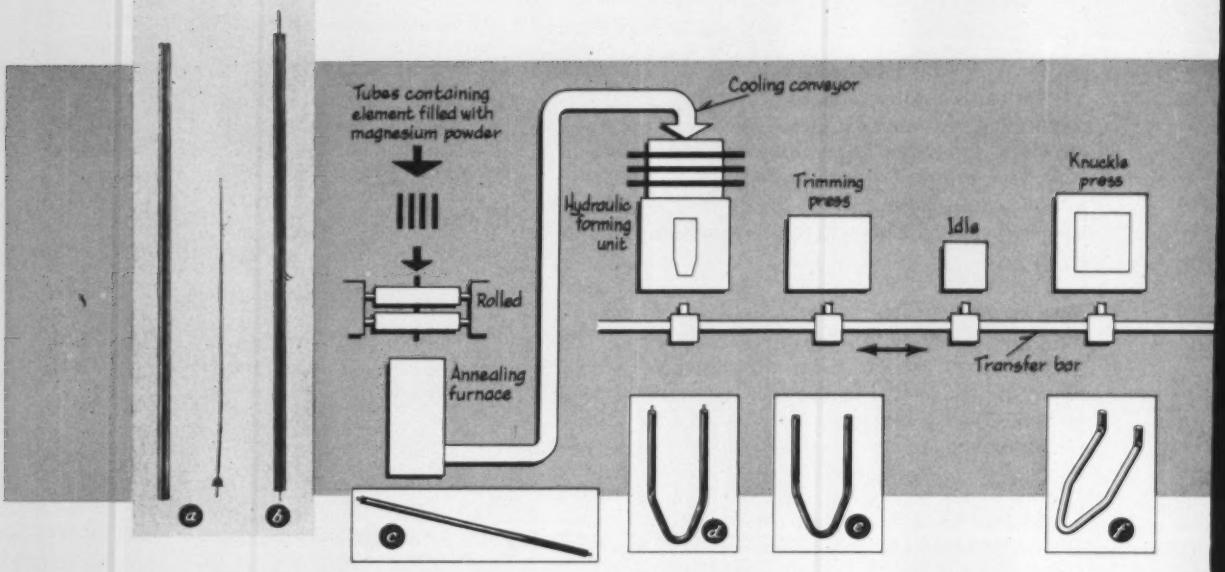


Fig. 4—Upper runway feeds cans from redraw press to this six-spindle combination trimmer and flanger. Lower runway is a bypass for cans that require only one drawing operation. Cans are escaped onto turret spindles by a star wheel. As the turret rotates, the spindles revolve about their own axes and turn the cans against trimming and flanging tools. In the center background is an elevating unit which lifts the flanged cans to storage runway leading to the packing position.

A recent development of the Central States Can Corp. is an easy-opening lid for aluminum cans which embodies a tear strip to remove the lower lid seam. The lid itself has a deep, counter-sunk shape so that it may be placed back on the can as a snug-fitting plug. Cans of this type require an additional curling operation before packing. In this case, the cans are diverted from the packing storage runway and are processed through a rotary curling machine that curls the flanges of the can in preparation for the crimping of the easy-opening lid to the body. An elevating unit lifts the curled cans back to ceiling level and discharges them into the storage runway for the packing position.



COST-SAVING PRODUCTION

TUBULAR resistance heater units are important components in the electrical appliance industry and literally millions of these units are used annually. As an example of how the heater units are applied, the Electric Appliance Div., Westinghouse Electric Corp., casts them into sole plates for electric irons. The number of units required for irons is so large that an automated production line has been established to effect higher economy in production and also to improve the quality of the units.

Each unit is manufactured from a cut length of 0.320 inch diameter tube and a nickel-chromium resistance wire. The wire is wound into a helical coil with its ends welded to short terminals. This coil, equipped with a plastic plug at one end, is inserted into the tube where it is stretched axially. A set of 24 such tubes and inserted elements is placed vertically in a special machine where the space within the tubes and elements is filled with dry magnesium oxide powder as the tubes are vibrated. Upon removal, a plastic plug is placed at the top end of each tube, and the tube is crimped onto it.

The handling involved in tube preparation is the only manual operation involved in production of the heater units, and it is accomplished by one man who tends two filling machines, loaded alternately. The magnesium oxide powder keeps the heating elements centered within the tubes. In the end application, the powder acts both as an electrical insulator and as a conductor of heat from the elements to the tubes. Despite subsequent working, the elements remain insulated, although the coil is reduced in diameter and flattened, along with the tube, in subsequent operations, *Fig.* 1.

After end crimping, each tube is placed in a hopper that feeds the tubes automatically to a 12-station rolling machine at the start of the automated line. Rolling reduces the tube diameter from 0.320 to 0.250 inch and increases its length about one third. At the same time, the magnesium oxide powder is compacted. Tubes discharged from the rolls feed automatically onto a transverse chain conveyor that carries them through a short annealing furnace. Gas burners in the furnace heat the tubes to approximately 1650 F and burn off the plastic plugs in the tube ends.

Tubes drop from the end of the furnace chain into a chute and feed automatically onto a chain conveyor where they cool during delivery to a hopper that feeds a special hydraulic forming machine, the first unit in a series of individual machines served by a single parts handling system. Transfers from the forming station to all subsequent stations on the automated line are by fingers that are shuttled back and forth on a common bar moved parallel to the line by the plunger of a hydraulic cylinder. This keeps all transfers synchronized by a simple and reliable means.

At the first forming unit, *Fig.* 2, lubricant is applied by a felt pad as a tube drops to forming position centered opposite a punch. As the punch is advanced, the tube is formed to hairpin shape around the punch by a pair of rolls in the die. After forming, the workpiece is elevated, gripped by transfer fingers, and transferred to a press where ends are sheared off to length. The workpiece next advances to an idle station. Since the transfer mechanism is a shuttle bar system in which the parts are gripped, the idle stations in the production line are essentially individual units with the capability of accepting workpieces and maintaining their orientation. In

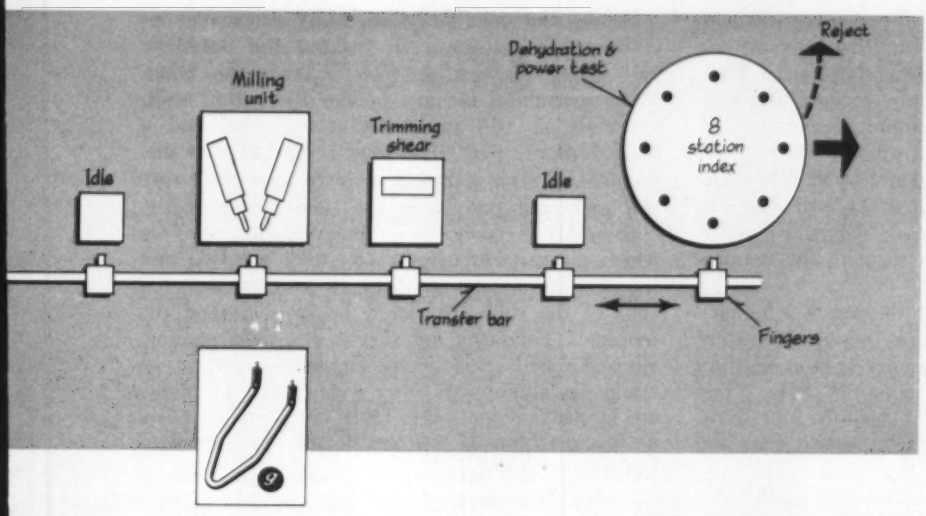


Fig. 1—Sketch indicates major equipment items in automatic line for production of heating units destined to be cast in sole plates of electric irons. Examples of workpieces at various stages of manufacture are also shown. Two parts, tube and heating element, (a), are combined into assembly (b), and filled with powder; assembly is rolled to make part as in (c), and after annealing, is formed into part (d). In subsequent operations part is trimmed (e), flattened and formed (f), and ends are milled, (g).

OF TUBULAR HEATER UNITS

the succeeding transfer, the workpiece is deposited into the die of a knuckle press, *Fig.* 3, where a blow flattens the whole tube except for its two ends. During this operation the two cylindrical ends are formed to an angle to the flat face. Flattening is done to permit the unit to be cast into an aluminum sole plate of moderate thickness.

Following the next transfer to an idle station, fingers advance the unit to a machining station where two hollow mills—advanced, driven, and retracted by drill heads—cut back the tube at the two ends and leave the center terminals bare. Following this, the ends of each terminal are sheared square and to length by a press at the next station.

After air blowoff to remove chips, each unit is advanced into a station on an indexing machine, *Fig.* 4.

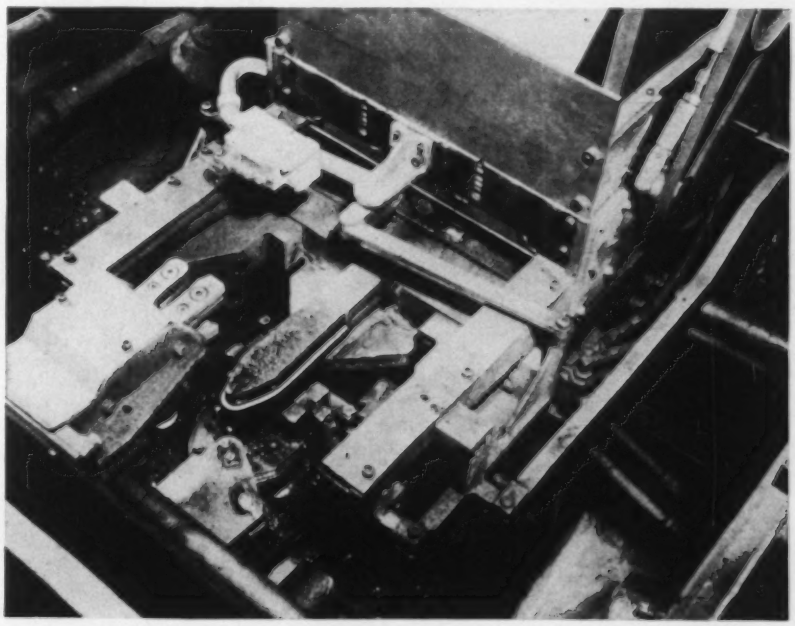


Fig. 2—In special hydraulic machine, part is formed into hairpin shape. Straight tube is fed into position from hopper (top of picture) and formed by rollers bending piece around punch. Subsequently, part will be stripped off punch and grasped by fingers of transfer device (bottom, left).

There the two terminals of the heating element make contact with power circuits that energize the resistance coils while electrical tests are made. During a test, heating evaporates any moisture that may have been picked up by exposure of ends of the magnesium oxide insulation. A ground test is made at 1350 volts and an insulation test at 600 volts, both automatic, with rejection if the unit does not pass the tests. Static type Cypak electrical controls are used instead of relays to regulate the requirements of the line.

Units that pass the tests are shipped to a foundry for casting into aluminum sole plates. A sealing compound is applied at the foundry to keep moisture from being absorbed by the magnesium oxide. When the castings are returned for assembly into irons, terminals of the cast-in unit are welded onto the terminals of the control circuit.

Besides the ones described, other automatic operations are performed in making the resistance wire assemblies that are placed inside the tubes. These assemblies include, besides the helical coils, terminals of 1010 steel wire at each end and a molded plastic plug. The plug is pushed over one terminal of each assembly to serve as a temporary seal and hold powder in the tube during filling.

Assembly is made on an indexing dial setup to which all parts except the coil itself are fed from hoppers. Terminals are held by clamps, and the ends of the coils are placed by hand around the terminals. Following indexing to the weld position, electrodes make 360 degree resistance welds in an argon gas atmosphere. After welding the assemblies are ejected automatically. Only one man is needed at this machine. It operates at the same speed as the automated line.

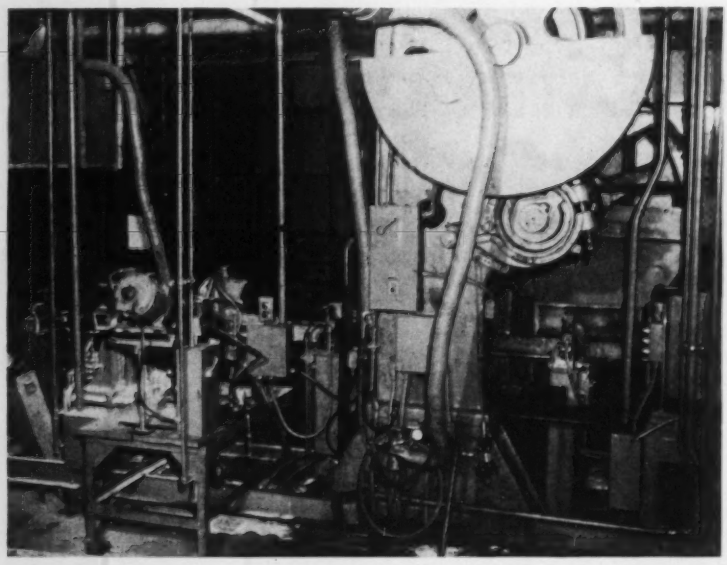


Fig. 3—View of rear of line suggests how individual equipment items were arranged to form automated line. Parts move from right to left. Major items shown are knuckle press (center) and hollow milling machine (left). Just to either side of knuckle press are located separate idle stations.

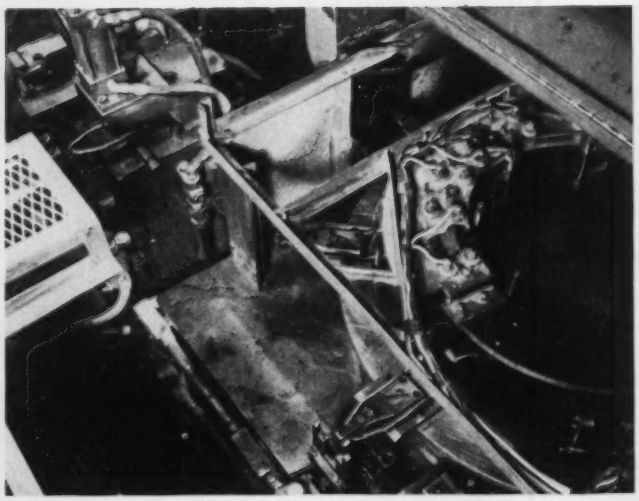


Fig. 4—Part of 8-station dial index testing machine is shown. During electrical test, part is heated to evaporate residual moisture in magnesium oxide insulation. Awaiting transfer into testing machine, part can be seen in idle station (top, left).

STUD WELDING SOLVES HANDLING PROBLEM

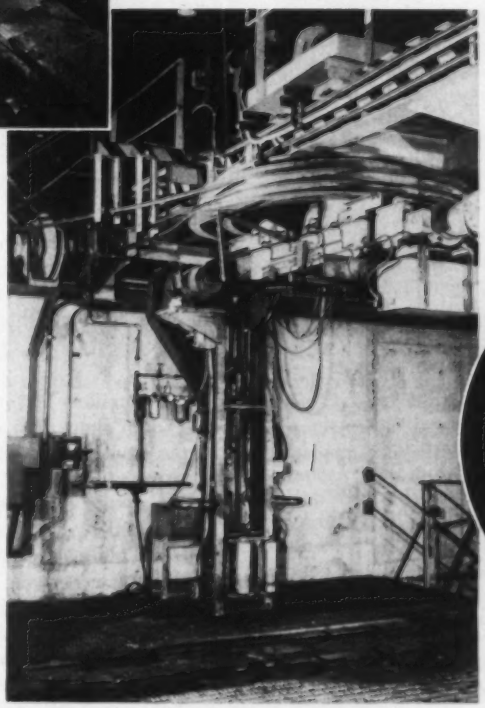
FLAPPING coil ends create many problems in handling coils of strip steel. When the coils are coming from a hot strip mill at temperatures around 1000 F, many conventional means of fastening the coil ends to the coil are not satisfactory. To avoid handling problems in such a situation, Armco Steel Corp. has developed an automatic positioner that carries a stud welding gun.

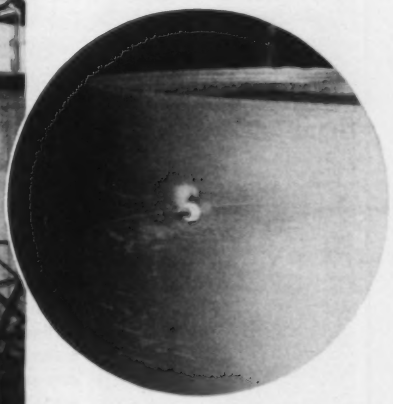
The positioning mechanism consists of a vertical arm suspended from a rotating assembly which is mounted above the conveyor transporting up-ended coils from the hot strip line. The arm can traverse a 270-degree arc around a coil on the conveyor. When a coil is in position, the arm moves in and presses the outer lap of strip against the coil with a pair of roliers. The arm then rotates around the coil toward the coil end. The rollers push the loose tail end into a tight fit with the underlying layers.

Fastening of the coil end is performed with a plugweld gun manufactured by Nelson Stud Welding Div., Gregory Industries Inc. The gun is mounted on the vertical arm so that it can advance between the two rollers which position the coil end. A stud and ferrule are loaded onto the gun before each operation. At the touch of a button the operator causes the welding gun to move forward between the rollers and fasten the tail to the inner layer of the hot strip coil.

A knock-off type stud of suitable dimension and design is used to secure the coil end of the particular gage being run. One or two studs are welded to each coil, depending upon the size of strip being rolled. Coils are unfastened prior to subsequent processing by placing them on cradle rolls and reversing the rolls a couple of times to shear the welds.

Speed at which coils can be secured, a matter of seconds, plus the ease of handling positively secured coils have produced substantial improvements in operations. Operators have also benefited since they work more safely with less direct exposure to the heat of the coils.





Arm supported by overhead structure can swing 270 degrees around hot coils on the floor level conveyor. When a coil is positioned as shown in the square inset, two rollers on the arm contact the outer layer of the coil and iron it against the coil as the arm moves. A plug welding gun advances between the rollers to fasten the coil end to the underlying layer with a knock-off type stud as shown in the circular inset.

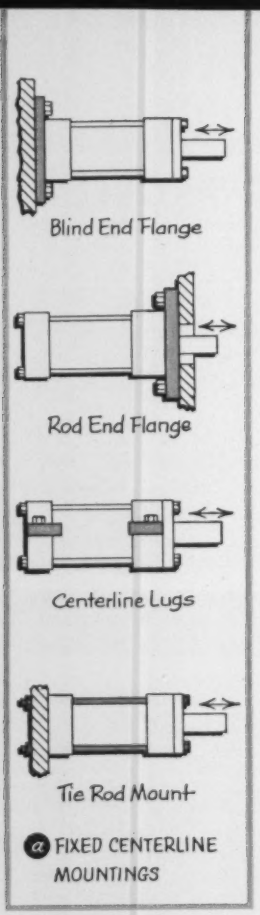


Fig. 1—Fluid power cylinders are available with a variety of mounting arrangements. Fixed centerline mountings, *(a)*, and pivoted centerline mountings, *(b)*, provide for piston rod thrust to be taken up along cylinder centerlines. Cylinders with fixed noncenterline mountings, *(c)*, are convenient in many applications where thrust may be taken up at offset mounting surfaces.

PRACTICAL GUIDES TO

By **Z. J. LANSKY**, Division Manager, Hannifin Co., Div., Parker-Hannifin Corp., Des Plaines, Ill.

PROPERLY APPLIED, fluid power cylinders can provide outstanding performance as actuators in a variety of automatic machines and devices. Advantages of hydraulic and pneumatic cylinders in this type of service stem mainly from their relative flexibility of application, large force-exerting capabilities, and high power per unit weight and size. Hydraulic cylinders, in particular, offer the additional desirable characteristics of mechanical stiffness and high speed of response to control commands. These characteristics account, in part, for the wide use of hydraulic cylinders as actuators in precision control systems, such as electro-hydraulic servo positioners.

Widespread and growing applications of fluid power cylinders in industry suggest that a review of basic selection and application criteria would be of interest to many manufacturing engineers. Accordingly, this presentation will cover some of the important factors that should be considered in specifying, installing, and maintaining fluid power cylinders. Although linear-motion cylinders will be discussed, many of the factors will apply to rotary fluid power actuators as well.

Basic Cylinder Design

The choice of supplier for a fluid power cylinder will largely determine the basic design of the unit. It is at this point in the selection stage that the envelope and mounting dimensions are set and interchangeability with cylinders made by other manufacturers is established. The choice of supplier will also fix the type of cylinder construction which will be used.

Construction features should be carefully considered in light of a particular application. For example, the method of fastening the cylinder heads to the cylinder body is closely related to physical design of the end product. As to gland design, the manufacturing engineer should verify that the gland will provide a drip-proof seal automatically without the need for periodic adjustment. The effective piston bearing length should be adequate for the job and the joint between the piston and piston rod should have the necessary strength. Materials, clearances, and finishes used in fabricating the cylinder

POWER CYLINDER APPLICATION

Unique characteristics of fluid power cylinders will ensure continuing use of these versatile components as actuators in a variety of automatic production machines. The author discusses some of the factors involved in properly specifying, installing, and maintaining hydraulic and pneumatic cylinders of the straight-line motion type.

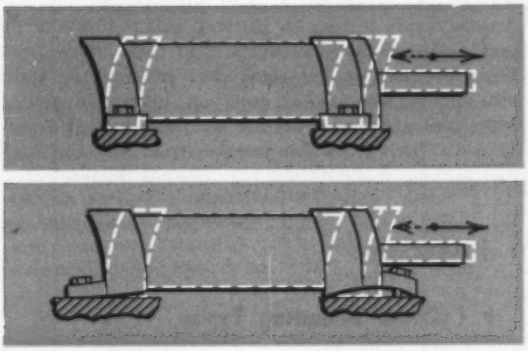


Fig. 2—In applications involving large forces, cylinders with noncenterline type mountings tend to sway under load.

should meet any special requirements of the application.

▶ Pressure Ratings

Unfortunately, there is no standard method of establishing pressure ratings for industrial cylinders. Some manufacturers rate their cylinders on the basis of ultimate strength; others publish pressure ratings based on yield strength. There is also no consensus on a safety factor. Some cylinder designers use a safety factor as low as 2 to 1 based on ultimate strength, and others specify 3½ or 4 to 1 on yield.

Industrial cylinders are usually designed to have a unit tensile stress of 12,000 to 15,000 psi in the cylinder body at rated working pressures. Since the cylinder body is generally made from low carbon, cold drawn steel tubing which has a tensile yield strength of about 55,000 psi, a safety factor of approximately 4 to 1 on yield is provided at rated pressures. This is also the minimum safety factor specified by several automobile manufacturers for their standardized, heavy duty automation cylinders. In many portions of these components the safety factor is much higher. Hydraulic cylinders currently being designed for use with missile launching equipment also have a specified design safety factor of 4 to 1 based on yield strength.

Dimensional changes occurring in stressed cylinders may further limit the allowable working pressures since large dimensional changes can seriously affect the performance and life expectancy of nonmetallic seals. For example, extrusion failure of syn-

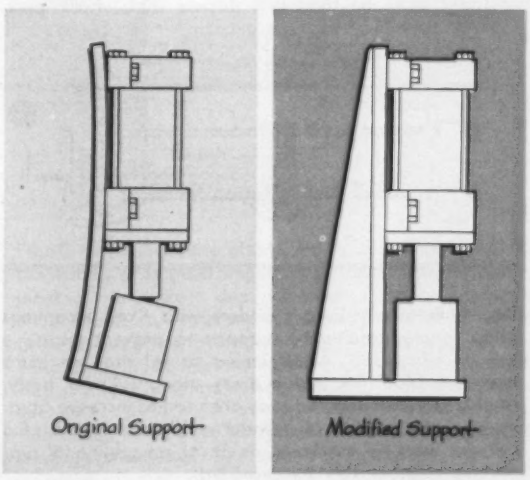


Fig. 3—Use of noncenterline type cylinder mountings may require strengthening of machine members to resist bending under load.

thetic seals can occur whenever diametral clearances exceed 0.010-inch with cylinder pressures in excess of 3000 psi.

To illustrate, consider a steel cylinder body, hardened to Rockwell C-35 to 40, with a tensile yield strength of approximately 160,000 psi. If a design safety factor of 4 to 1 on yield is specified, the cylinder body can apparently be stressed to 40,000 psi at rated working pressure. While this is rational from the stress standpoint, it must be remembered that the diametral change occurring in the cylinder will now be more than three times that of the same size cylinder stressed to only 13,000 psi at a lower working pressure.

With a 6-inch diameter bore and an initial diametral clearance of about 0.006-inch between the piston and the bore at zero pressure, the clearance for a steel cylinder stressed to 13,000 psi will increase by about 0.0026-inch for a total clearance of 0.0086-inch under full working pressure. The same size cylinder, stressed to 40,000 psi under a higher working pressure, will have an increase in clearance of 0.008-inch for a total of 0.014-inch. Its seal, if a synthetic type, would probably fail under these conditions.

The effect of high shock pressures in hydraulic circuits is often overlooked. When circuits include speed control devices or energy absorbing devices such as cylinder cushions or deceleration valves, shock pressures can raise internal cylinder pressures to levels 2 to 3 times those of normal circuit pressures. These effects occur during speed changes or slowing and stopping of machine members, and create additional diametral clearances during such times.

In general, if the published pressure rating of a cylinder is based on too low a safety factor or results in excessive unit stresses, operation at that pressure may cause unsatisfactory performance, failure, or a short useful life. If the circuit in which a cylinder is to be used can impose high shock pressures in the cylinder, additional derating will be required.

Working Medium

If air is used as the power source, corrosion of cylinder bores may be a problem. In this case, steel cylinder bores should be plated to attain lasting corrosion resistant surfaces, or inherently corrosion resistant materials (such as brass) should be specified. Provision should also be made for positively lubricating the cylinders during operation.

With liquid power media, seal selection is important. This is especially so since the use of fire resistant fluids has become more generally accepted in manufacturing plants. Since fluid leakage must be minimized in order to reduce losses of expensive fluids and to maintain good housekeeping in machine areas, seals are desired that have zero wipeage or dynamic fluid loss characteristics.

To date, there is no universal seal material which can prevent all leakage and is compatible with all the common types of oil base and fire resistant hydraulic fluids in use. In general, seal manufacturers and designers tend to agree that seals made from Buna N and similar elastomers provide the most efficient sealing performance on lubricated shafts. Most seal manufacturers are working on seal developments both from the standpoint of physical configuration and chemical composition of the elastomer. As a result, seals for hydraulic cylinders are approaching more closely the ideal parameters for such components.

Cylinder Mounting Types

Assuming that the basic cylinder design, pressure rating, and working fluid have been established, the next step is to select the cylinder mounting type that will be best suited to the application. This choice involves consideration of the various mounting types available, which may be classified generally by whether or not thrust is absorbed on the cylinder centerline. Mountings where this action

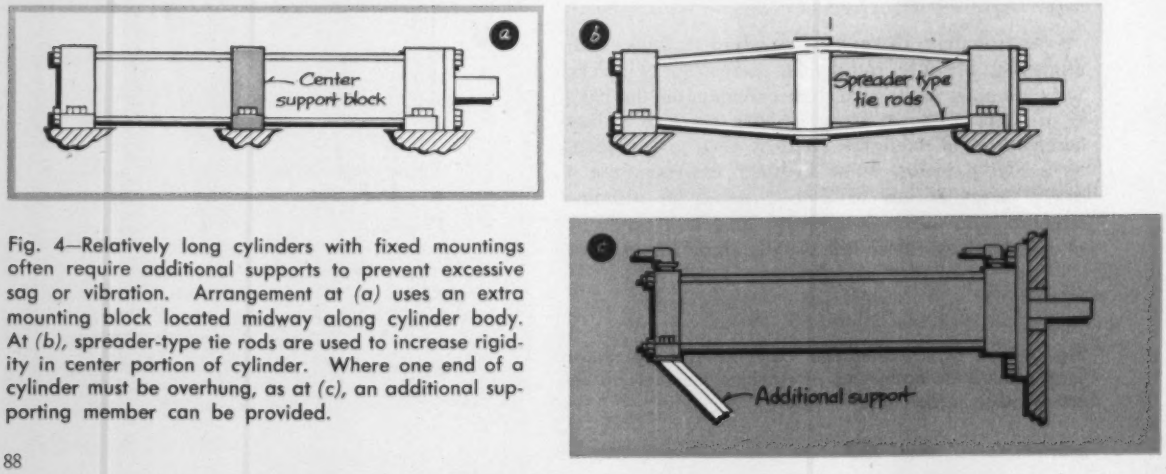
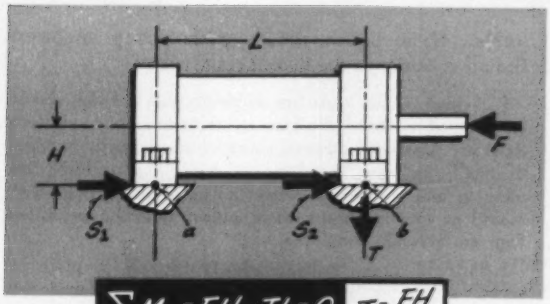


Fig. 4—Relatively long cylinders with fixed mountings often require additional supports to prevent excessive sag or vibration. Arrangement at *(a)* uses an extra mounting block located midway along cylinder body. At *(b)*, spreader-type tie rods are used to increase rigidity in center portion of cylinder. Where one end of a cylinder must be overhung, as at *(c)*, an additional supporting member can be provided.



$$\sum M_a = FH - TL = 0 \qquad T = \frac{FH}{L}$$

F - Load with rod extending, pounds

H - Distance from mounting surface to cylinder centerline, inches

L - Distance between centers of rod and blind end head mounting bolts, inches

S_1, S_2 - Shear forces

T - Tension in rod end head mounting bolts, pounds

Fig. 5—Relatively short, fixed noncenterline mounted cylinders can subject mounting bolts to large tension forces which, in combination with shear forces, overstress the bolts. Condition shown for a cylinder rod extending against a load illustrates manner in which tension is developed in rod end head mounting bolts. Note from formula that, for a constant load, tension increases with decrease in distance L between rod and blind end head mounting bolt centers. Similar analysis can be applied to determine stressing of blind end head mounting bolts by substituting for load F the rod tension force developed during retraction, and by equating moments about point b to zero.

does occur are available in fixed mount styles and pivot mount styles, *Fig.* 1*a* and *b*. In mounting types where thrust is not absorbed on the cylinder centerline, *Fig.* 1*c*, the thrust from the piston rod is taken up at a mounting surface that is usually parallel with, but not coincident with, the cylinder centerline.

Specification of the type of mounting for a cylinder depends largely upon the application. Some of the factors that should be considered include:

1. Cylinders with noncenterline type mountings tend to sway under load, *Fig.* 2. Resulting additional wear on the cylinder can shorten the useful life of the component.

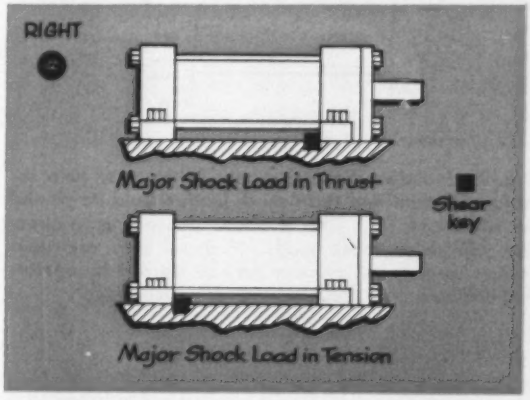
2. The rigidity of the machine frame should be taken into account. It should be remembered that cylinders with noncenterline type mountings often require stronger machine members to resist bending moments, *Fig.* 3.

3. If the motion of the machine member acted on by the piston rod is essentially linear, then in most cases a fixed mounting type cylinder should be used. If the machine member moved by the piston rod travels in a curvilinear path, a pivot mounted cylinder is the obvious choice. Pivot mountings are available with the pivot points on the rod end, on the blind end, or centrally located near the mid-point of the cylinder body. In most cases, a layout of the rod end path will determine the best pivot mounting type to be used.

4. The matter of cylinder strength versus stroke length should be considered. In general, long-stroke, pivot mounted cylinders of the center trunnion type can use smaller rod diameters without danger of buckling than similar cylinders with the pivot at the blind end. This can be verified by reference to stroke or buckling charts published by many cylinder manufacturers. Where long cylinders employ fixed mountings, additional supports are often required to prevent excessive sag or vibration, *Fig.* 4. Fixed noncenterline mounted cylinders with very short stroke lengths introduce another type of strength problem, *Fig.* 5. In this case, mounting bolts are subjected to increased tension which, in combination with shear forces, can overstress the bolts.

5. Selection of a mounting style also depends upon whether the major force applied to the machine will result in tension or compression of the cylinder rod. The blind end flange type mounting is best for thrust loads (rod in compression) and a rod end flange mounting is best where the rod is stressed in tension.

6. Alignment problems should always be considered. If misalignment can occur between a cylinder and the machine member it moves, it may be necessary or desirable to compensate for this in the selection of the cylinder mounting. For example, a simple pivoted centerline mounting will compensate for misalignment if the misalignment is primarily in one plane. Typical mountings of this type include clevis and trunnion arrangements. Where misalignment can occur in multiple planes, then the cylinder should be equipped



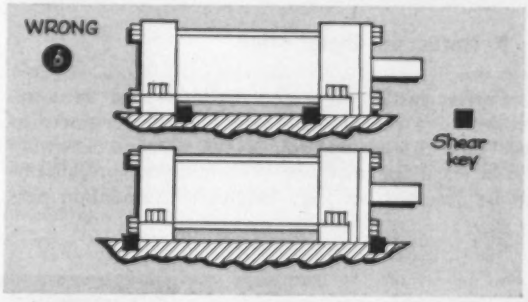
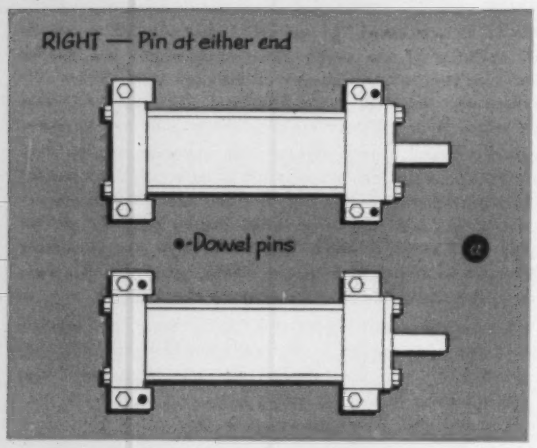


Fig. 6—Shear keys are often used to absorb shear forces developed at cylinder mounting surfaces. Proper placement of shear keys depends upon direction of major shock loads, *(a)*. Shear keys should never be mounted at both ends of a cylinder, *(b)*. Otherwise, shock-absorbing capabilities of cylinder elasticity can be lost, and changes in cylinder length due to temperature and pressure effects can cause trouble. Manufacturing tolerances for similar components could also make replacement difficult with such arrangements.



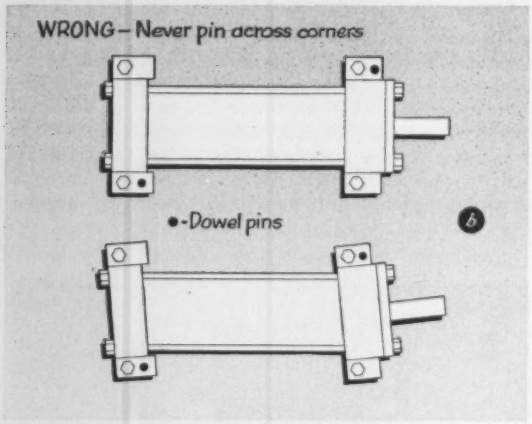


Fig. 7—Cylinders that are pinned in place to help secure alignment and resist shock loads should be pinned at either end, *(a)*. Choice of end depends upon direction of major shock load. If dowel pins are used across corners, *(b)*, cylinder may be warped by operating temperatures and pressures or shock loads.

with self-aligning ball joints both at the blind end of a clevis mounted cylinder and in the rod end member.

▶ Notes on Installation

Proper installation of a cylinder can be controlled to a considerable extent by the engineer at the time that a machine layout is made. Drawing notes clarifying methods of installation, precautions to be observed, etc., are helpful to installation personnel. Some points that manufacturing engineers should consider in the layout stage include:

1. If high shock loads are expected, the cylinder should be mounted so that full advantage is taken of the cylinder's elasticity. Using the inherent elasticity of a cylinder in shock situations can mean the difference between a successful application and one that is always giving trouble. High shock conditions usually require more rugged fastening provisions than are normally employed.

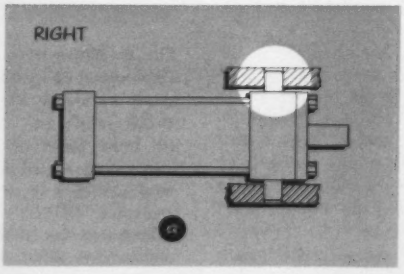
2. Fixed mounting cylinders should be held in place by keying or pinning, and some provision should be made for this. Cylinders with integral key mounts may be used where keyways can be cut in a machine member. This type of mounting takes up shear loads, provides accurate alignment of the cylinder, and simplifies installation and servicing.

3. The use of separate keys to take shear loads is relatively common. Shear keys should be placed at the proper end of a cylinder—at the rod end if major shock loads are in thrust, and at the blind end if major shock loads are in tension, *Fig.* 6. In a given installation, only one end of a cylinder should be keyed to the machine. If both ends are keyed, the advantages of cylinder elasticity in absorbing shocks will be lost. Temperature and pressure effects should also be considered. A cylinder that is mounted at room temperature and zero pressure may be subjected to working temperatures ranging from 120 to 140 F or more, and pressures of 2000 or 3000 psi. Under these operating conditions it is obvious that the cylinder length will increase over its installed length, and the cylinder should never be mounted so that it is not free to expand and contract. Even without the presence of serious shock, temperature, and pressure effects, use of shear keys at both ends of a cylinder is not advisable because of the difficulty of manufacturing a cylinder to an exact over-all length so that it will fit between keys located for another cylinder.

4. Locating pins may be used instead of shear keys to help take shear loads and to obtain cylinder alignment, *Fig.* 7*a*. Cylinders should be pinned at either end (not both ends) for the reasons mentioned previously. Occasionally a designer will carry over die design experience and call for pinning across corners, *Fig.* 7*b*. This can result in severe warping of a cylinder when it is subjected to operating temperatures and pressures.

5. Pivoted mounts should have the same type of pivots at the cylinder body and the rod end. If a simple pivot pin mount is used, the pivot pin axes at each end should be parallel. If a ball joint or self-aligning bearing is used at one end, a similar device should be used at the other. Trunnion mounts are generally designed to resist only shear loads. Therefore, self-aligning mounts should not be used to support the trunnions, since bending forces can also be set up, *Fig.* 8.

6. Misalignment that can occur when a fixed mount



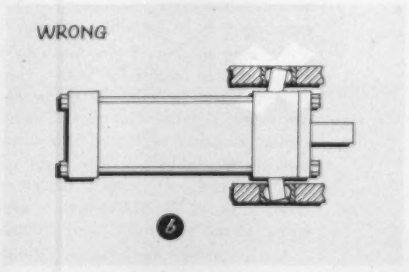


Fig. 8—Trunnions for pivot-mounting of cylinders are generally designed to resist shear loads only, *(a)*. Use of self-aligning bearings that have small bearing areas acting at a distance from the junctions of the trunnions and the cylinder head introduce bending forces that can overstress the trunnions, *(b)*.

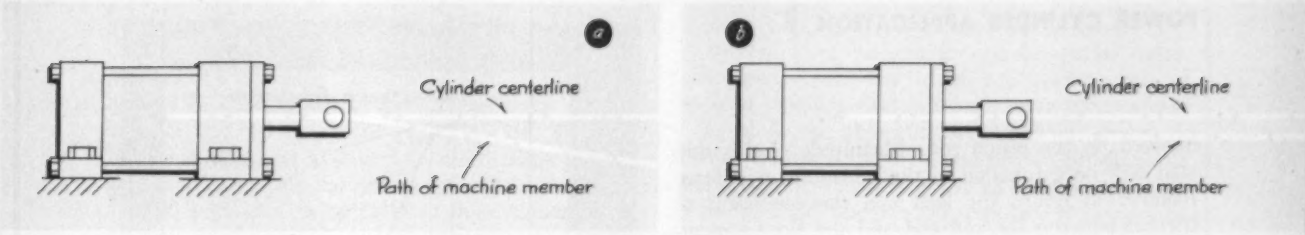


Fig. 9—Misalignment of fixed-mounted cylinders with work slides can be of two types. The cylinder can tolerate slight misalignment that increases with stroke, (*a*). It cannot operate properly with constant misalignment, (*b*).

cylinder is located so that its centerline does not coincide with that of the actuated machine member is of two types, *Fig.* 9. While such a cylinder may tolerate misalignment that increases with the stroke, it cannot tolerate misalignment which remains constant throughout the stroke. Section 6.3.2 of the Joint Industries Conference (JIC) hydraulic standards states that "Cylinders shall be located in alignment with work slides, and shall be such that no side or radial load shall occur on piston rod or ram, unless other suitable provisions are made to take such loads." This recommendation is a good rule to follow in mounting a cylinder. In some cases, misalignment is inevitable. When this occurs, an expedient is to mount the cylinder in the manner shown in *Fig.* 10. With this arrangement, oversize holes in the side lugs of a rod end cylinder head allow the rod end of the cylinder to move up and down with respect to a pair of dowel pins. The blind end head is fastened rigidly to the machine, and flexure is provided by the cylinder body.

7. In attaching a cylinder rod to a machine member, the rod should not be rotated unnecessarily as there is always danger of scoring the cylinder body. This is especially so if there is misalignment when the rod is rotated.

8. To facilitate gland maintenance, rod end knuckles, cam surfaces, and other projections should not be welded or otherwise fastened permanently to piston rods during installation. Another point related to maintenance is that when seals need replacement the rod bearing probably should be replaced also. Seal wear rates can be increased greatly when glands are oversize or worn.

9. Wherever possible, threaded joints should be pulled up tight against shoulders. This will minimize bending at necked-down sections and decrease fatigue stresses caused by reversal of forces in bending.

10. The effects of dirt and other foreign material should be considered at installation of a cylinder. The installation group should be reminded to take care that no paint or similar material is sprayed on an exposed cylinder rod and that damage to exposed rods should be avoided.

▶ Rod End Joints

In specifying a rod end joint, the engineer should carefully consider the thread to be used at the piston rod end. For example, the thread OD should be somewhat smaller than the full diameter of the piston rod to allow replacement of seals without scraping on the threads. Provision of thread relief, rather than runout of threads, provides a stronger rod end and reduces notch sensitivity. The advantages of female threads should be considered. Such threads are generally easier to service and, if breakage occurs, a stud can be easily reinserted. In general, fine pitch threads are stronger than coarse threads because of greater total thread root area.

The type of connection of the rod end to the machine member should be considered. The ideal rod end connection is found where the piston rod is threaded to a well-guided machine member. This arrangement gives the best possible support to the free rod end. Pivoted connections to moving machine members are usually not as critical on alignment as connections which are rigidly made to the members.

Some rod end connections which are generally considered to be self-aligning cannot, in fact, provide such action. An example of this is the slotted arrangement of *Fig.* 11. Here, the reduced-diameter section of a rod end engages a slot provided on a machine member that moves in a straight line.

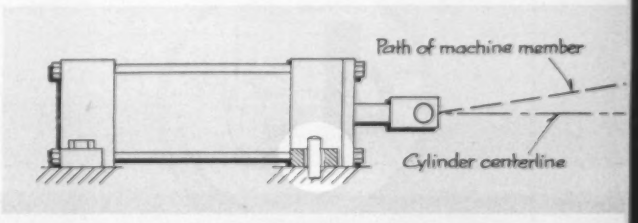


Fig. 10—Sometimes a relatively long-stroke cylinder can be made somewhat self-aligning by allowing the rod end head to float. In arrangement shown, holes in the side lugs at the rod end cylinder head permit some movement of front of cylinder with respect to dowel pins. Cylinder body flexes slightly about fixed rear mounting.

Because of necessary clearance at the connection, and normal clearance between the piston and the cylinder bore, the rod end follows the lower path when no force is being transmitted to the machine member. If the machine member offers sufficient resistance, the rod will follow the upper path during the outstroke of the piston rod. However, during reversal of the piston rod the force at the connection will be relieved momentarily and the rod end will drop to the lower position. During the remainder of the return stroke a side load will be

imposed on the piston rod. Magnitude of this side load will be a function of the horizontal pull force required to return the load and the coefficient of friction between the rod end and the slotted member. Scoring of the cylinder body could be one result of such a side load.

Piston Rod Diameter

Selection of the the proper piston rod diameter for a fluid power cylinder is based on several factors including buckling and bearing load conditions, type of rod end joint to be used, and circuit considerations. Typical points to remember are: The stroke length of a cylinder may be limited by rod buckling considerations. Here, the rod acts as a long column with one end semifixed in the cylinder and the other end fixed or pivoted to the machine member. Where rod buckling can occur, a feasible way to increase the stroke length is to go to a larger diameter piston rod unless the designer is willing to accept operation at a lower safety factor.

The stroke may be limited by allowable rod end bearing load or by bending of the threads at the junction of the piston and piston rod with the rod fully extended. Here, the use of a cylinder with a stop tube will help. The stop tube increases the minimum distance between the rod end bearing and the piston.

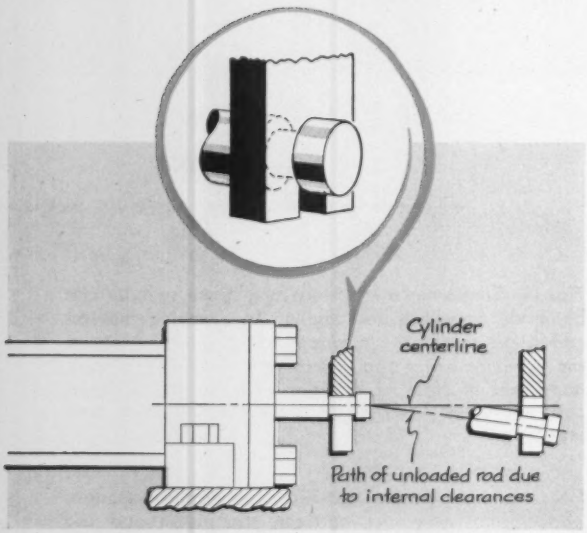


Fig. 11—Type of rod end connection shown—generally considered to be self-aligning—can introduce side load on a cylinder. During extension, piston rod end may follow cylinder centerline because of resistance of machine member and friction at connection. During reversal, however, load is relieved momentarily and rod end can drop to lower position. On return stroke, side load—equal to product of coefficient of friction at connection and horizontal pull force—is set up.

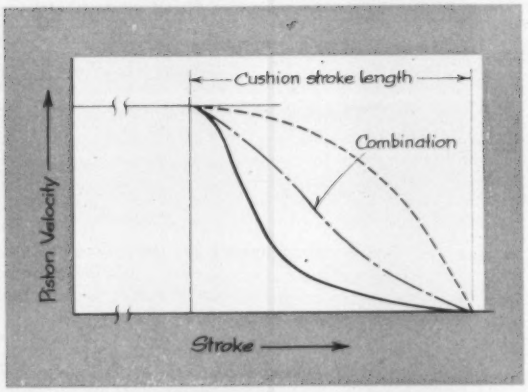


Fig. 12—Pistons can be decelerated at the ends of their strokes by means of cushioning arrangements. With needle valves, piston velocity may be reduced drastically at start of cushioning (solid line), leading to high shock pressures and vibration. Relief valve method (dashes) gives gentle initial action, but deceleration rate increases during last portion of cushioning stroke. Action labeled "combination" is obtainable with circuits of *Fig.* 13.

Vibration and misalignment can require the use of cylinders with large rod diameters. Usually, the bearing area at the rod end gland is increased with larger diameter rods. Sometimes the rod end joint determines the rod diameter selected. For example, if a large shoulder is required at the end of the rod because of high bending forces, only a large diameter rod will suffice. Special rod end joints may also require large diameter rods.

Circuit considerations can affect the choice of rod diameter. The most common example of this is where a differential circuit is used. Usually, the cross sectional area of the piston rod is one-half that of the cylinder bore. In some cases, required speed or force ratios for advance and retract strokes call for other cross-sectional area relationships.

In some instances, a dual force device is obtained by use of rod diameters to suit the need. One good example of this is the use of a 7-inch bore cylinder with a 5-inch diameter rod on one end and a 3-inch diameter rod on the other end, used to operate a steam charging valve on the Navy's new steam catapults. The 3-inch diameter rod is used to provide a larger area to open the valve than is available to close it. Thus, regardless of what force is available to close the valve, we always have the difference in area between a 5-inch rod and a 3-inch rod to help open the valve.

Bleeding Hydraulic Cylinders

In critical applications where the presence of air in a hydraulic cylinder can cause erratic operation,

air removal or "bleeding" may be required. This can be accomplished by strategic mounting and piping of the cylinder. Involved is locating the ports leading to the cylinder at the highest point of the cylinder and arranging the piping so that air will be returned to the reservoir or some point in the circuit where it can be removed.

Bleed ports can be provided in the cylinder body itself or in the cylinder head. Construction of the cylinder should be such that effective bleeding will be accomplished. This requires that there be no voids in the piston which may be difficult to purge. Continuous bleeds can be made from capillary tubing. Special devices may be used instead if their action approximates that of a long capillary tube.

▸ Cushioning

Pneumatic and hydraulic cylinders are frequently equipped with cushioning devices. One function of a cushion is to provide absorption of the energy of moving masses at the ends of strokes. This includes the masses of the piston and rod, the load which is being moved, and the fluid medium operating the cylinder. Although it might seem that the energy content of the fluid medium is relatively small, it should be remembered that the kinetic energy of a moving mass is proportional to the square of its velocity. Consider, for example, a hydraulic cylinder having a 6-inch bore being fed by a line with a 1-inch bore. Whatever the speed of the piston, the fluid in the line is moving at a velocity 36 times that in the cylinder. Therefore, the kinetic energy of a given mass of fluid in the line is almost 1300 times that of the same mass of fluid in the cylinder. This kinetic energy, as well as that of the fluid in the cylinder, the piston and rod, and the load being moved must be absorbed by the cushion in stopping the mechanisms.

From the standpoint of the cylinder manufacturer and the user, cushions also prevent cylinder damage. This is accomplished by the removal of energy over a sufficient length of cushion stroke so that peak forces and pressures will not build up in sufficient magnitude to damage a cylinder.

A standard cushion will reduce the speed over the last portion of a stroke, but is not designed to provide reliable secondary speed control. Difficulties may be encountered, for example, if very slow primary stroke speeds are involved, since cushions are generally designed to absorb relatively high energy levels in limited time intervals. A cushion may be relatively ineffective or erratic in smoothly and consistently reducing a low primary stroke speed.

Cushioning of pneumatic cylinders often introduces special problems which are characteristic of the fluid medium used. Bounce is an effect which is caused by the absorption of the kinetic energy of moving masses without completely exhausting the compressed air which has provided cushioning action. At the moment that motion stops, some air may be stored under pressure and tend to reverse the motion of the piston. This phenomenon may occur several times in rapid succession at the end of a piston stroke. The usual remedy for piston bounce is to adjust the cushion controls so that the cylinder completes its maximum stroke at the instant that all of the kinetic energy has been absorbed.

The effect of unswept volume should be considered in selecting a cylinder where cushioning is a problem. For example, a cylinder with long cushion engagement may not have the same energy absorb-

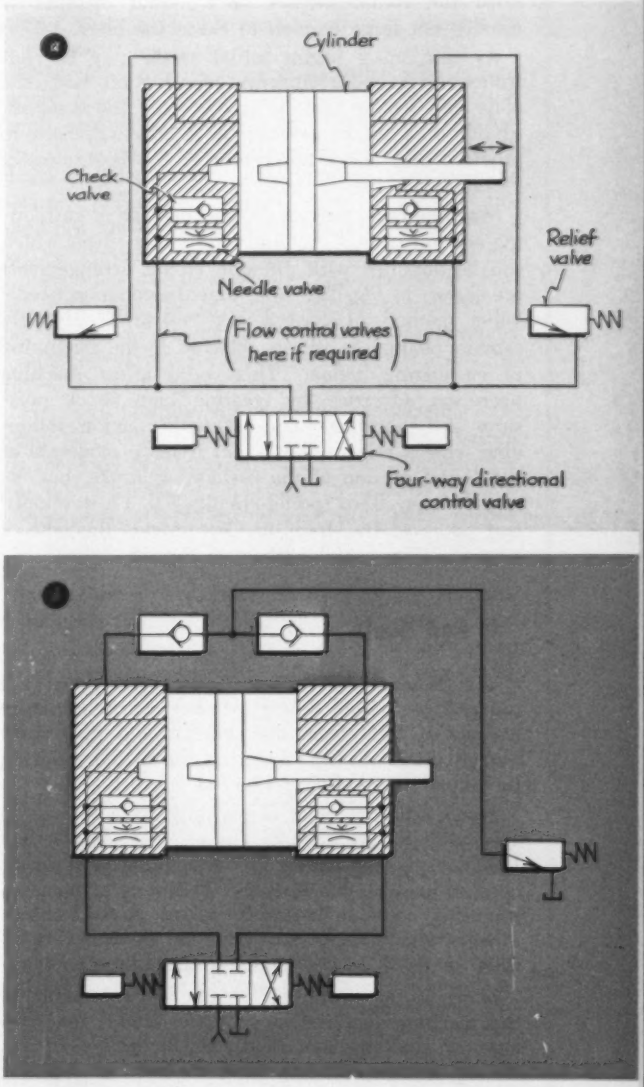


Fig. 13—Relatively uniform deceleration of a piston can be accomplished with either combination cushioning arrangement shown. In each circuit, fluid is expelled from cylinder at end of stroke along parallel paths through a needle valve and a relief valve. Circuits *(a)* and *(b)* differ only in that, in circuit *(b)*, two check valves substitute for one relief valve.

ing capacity as a similar cylinder equipped with a short cushion. This occurs where large unswept volumes (with long cushions) reduce the cushioning action. In general, the greater the unswept volume the lower will be the compression ratio for a given cushion stroke length.

The energy absorbing capacity of a pneumatic cylinder cushion can often be increased by building up additional back pressure with a meter-out flow control valve; by decreasing the unswept volume of the cushion stroke; and by increasing the cushion stroke length if unswept volume is not increased materially.

Cushioning of hydraulic cylinders introduces problems that are somewhat different from those encountered with pneumatic cylinders. Bounce effects are virtually nonexistent with hydraulic cylinders, since the compressibility of a liquid medium is usually not large enough to cause trouble.

As cushioning begins initial shock may be controlled by suitable entrance tapering on both the male and female cushion parts. Also, the compressibility of a liquid medium is usually sufficient to provide some shock absorption at the beginning of cushioning action.

Machine requirements dictate the type of cushioning action required. Typical cushioning effects which can be obtained with different circuit arrangements are shown in *Fig.* 12. Note that the common needle valve method of control may cause a relatively sudden change in piston velocity at the beginning of cushioning action. This could affect machine operation adversely by creating high shock pressures and vibration. The cushioning action obtainable with a relief valve circuit is more moderate at the initial portion of the cushioning stroke, but increases later. Two special circuits, *Fig.* 13, developed and patented by Hannifin Co., provide the type of action labeled "combination" in *Fig.* 12.

Rod Seals

The functions of a sealing arrangement at the rod end of a fluid power cylinder are to minimize leakage of fluid from the cylinder and to exclude foreign materials from entering the cylinder during the return stroke of the piston rod.

Many different types of packings have evolved to cope with the problem of loss of fluid. In the late 1930's, a packing with a "V" shape had been developed to control this leakage. This type of packing, commonly used in hydraulic cylinders, worked relatively well. There was little or no collaring of fluid off the rod, and relatively little dripping.

However, as hydraulics became more common in the machine tool industry, it was found that this type of packing was relatively ineffective in excluding foreign materials from the cylinder. Metallic

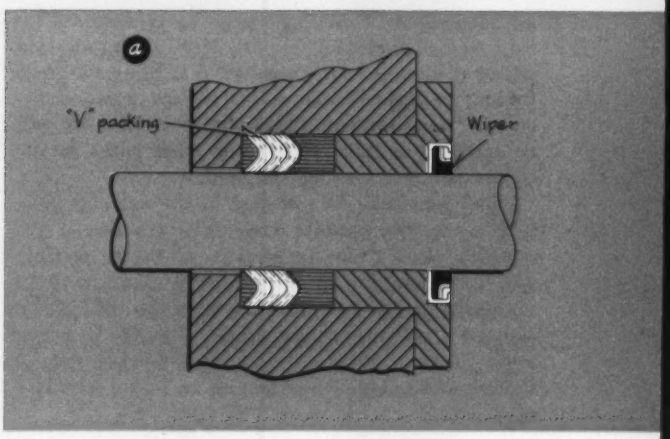


Fig. 14—Combination rod sealing arrangements perform dual functions. In *(a)*, "V" packing reduces leakage of pressurized fluid from cylinder. Wiper prevents foreign materials from being drawn into cylinder during return stroke of piston rod. Arrangement at *(b)* includes two synthetic-type seals in an assembly that can be removed from cylinder as a unit. Inner seal performs primary sealing function. Oil getting past primary seal is trapped in cavity formed by inner lip of outer seal and deposited on rod for return to cylinder during return stroke. Outer lip of outer seal performs wiping function to exclude foreign materials.

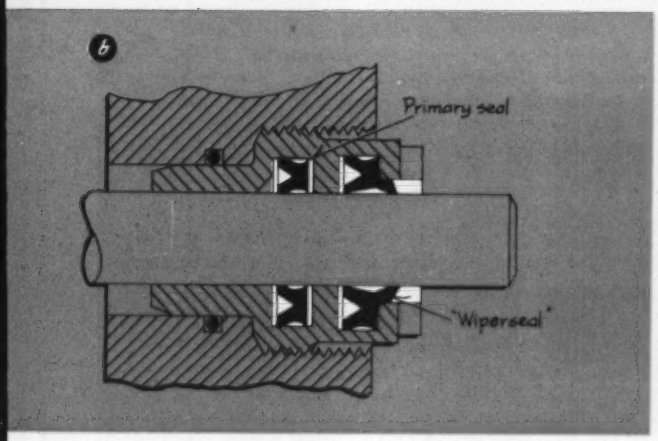
particles, chips, and other foreign materials adhering to the piston rod were too easily drawn past the packing and bearing and into the cylinder. Bearing damage, rod damage, contamination of the fluid, corrosion of parts, and clogging of valves and lines often resulted. Decreased packing life and added maintenance for filter and separator elements also occurred.

To cope with the problem of excluding foreign materials, cylinder manufacturers started to add rod wipers to the gland of their components, *Fig.* 14*a*. However, this often resulted in the oil film being collared off the rod by the wiper and the formation of oil puddles below the glands of cylinders so equipped.

Wipers have undergone considerable development to the extent that, today, a variety of efficient exclusion devices is available. Where materials adhere tightly to reciprocating rods, metal scrapers are often employed. One seal design combines a synthetic wiper and metal scraper in a single unit.

A gland sealing arrangement developed by Hannifin Co. is shown in *Fig.* 14*b*. This assembly employs a primary inner seal to accomplish the major fluid retention job. Because the primary seal is deformed slightly by the pressure of the hydraulic fluid it is sealing (especially in cases where a meter-out circuit is used), some fluid does get past it. This fluid is sheared off the rod by the inwardly projecting lip of a second, outer seal and stored temporarily in a cavity formed by the lip. Since the outer seal is not subjected to fluid pressure, it is not deformed and hence does not leak.

An outwardly projecting lip on the outer seal



performs the wiping function to prevent the entrance of foreign material into the cylinder. During the return stroke of the piston rod, the oil stored in the cavity of the inwardly projecting lip of the outer seal is deposited on the rod and carried back into the cylinder past the primary seal and rod bearing. The entire sealing assembly, in the form of a removable cartridge gland, is piloted and threaded to the cylinder head. The assembly can be removed without dismantling the cylinder, and either the seals or the entire assembly replaced.

▶ Stroke Speed Control

In most cases the traverse velocity of a cylinder is established by circuit or application considerations. Where the application calls for a definite traverse rate, there is seldom a problem in controlling the cylinder within reasonable limits. However, difficulties related to lack of speed control can arise in some cases. For example, high traverse rates that can occur without speed control can introduce problems of stopping the cylinder and load.

The traverse velocity of a hydraulic cylinder may be limited by pump capacity or by means of flow control valves. Speed control by pump capacity is fairly simple if one pump is operating one cylinder. It becomes more difficult if one pump is used to operate several cylinders simultaneously.

The use of flow control valves to limit hydraulic cylinder speeds is particularly important in systems where very large fluid supply capacities are available, as in central supply systems. In a typical system of this type, a large pump and accumulator arrangement serves many cylinders, each of which is controlled by an individual four-way valve. Such a system may operate well when all the cylinders are in operation simultaneously during a normal work cycle. However, where only one cylinder may be actuated at a time, a virtually infinite source of fluid supply becomes available to that cylinder. Piston velocity is then limited only by the length of stroke, since the piston is being constantly accelerated by the fluid pressure available. In such a system, the use of flow control valves is mandatory to prevent damage to the cylinder or machine.

Other hydraulic systems which approach infinite supply characteristics include those where a single pump and accumulator supply a single cylinder, *Fig.* 15. Pump energy, at relief valve pressure, is stored in the accumulator during idle cylinder periods. When the control valve is shifted, the combined outputs of the pump and accumulator become available to the cylinder. Here again, use of flow control valves between the directional control valve and the cylinder may be mandatory if the capacity of the pump/accumulator combination is relatively large in comparison to the displacement volume of the cylinder.

The force buildup characteristics of hydraulic cylinders in circuits which include flow control valves (in meter-in or meter-out arrangements) are such that full force is available on a practically instantaneous basis. This is because the liquid media used in hydraulic systems are relatively incompressible.

Speed controls are important in many applications of pneumatic cylinders. Often, the source of air supply will appear to have a relatively large capacity from the standpoint that the air will expand

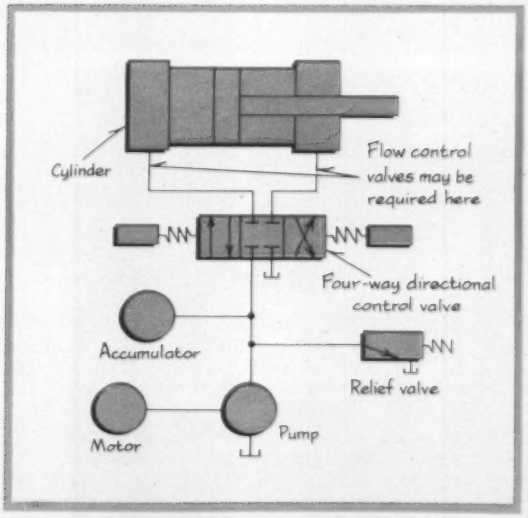


Fig. 15—Flow controls are usually required to limit attainable piston velocities in hydraulic systems where fluid supply capacity is large with respect to displacement volume of cylinder. In system shown, combined capacities of pump and accumulator are available to operate cylinder when directional control valve is shifted. Constant acceleration of piston by large volume of pressurized fluid could result in extremely high velocities and cause damage to machine members or cylinder. Addition of flow control valves in lines between cylinder ports and directional control valve would reduce maximum piston velocity in either direction to safe value.

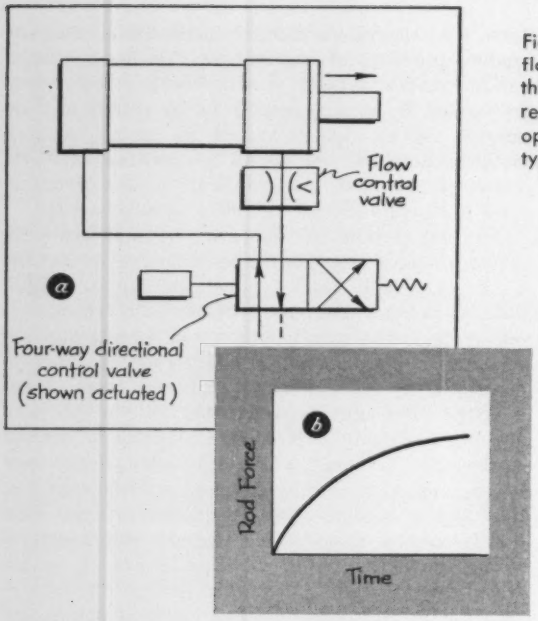


Fig. 16—Control circuit for pneumatic cylinder includes flow control valve in meter-out arrangement, *(a)*. With this type of speed control, buildup of rod force with respect to time is relatively gradual, *(d)*. Cylinders operated by liquid media respond more rapidly in this type of circuit because fluid is less compressible.

and continue to accelerate the piston once motion has been started. Some control is possible by means of flow control valves, although erratic action can result because of the difference between the coefficients of static and dynamic friction for the cylinder. Speed control sometimes results automatically because of the nature of the load or the air supply available.

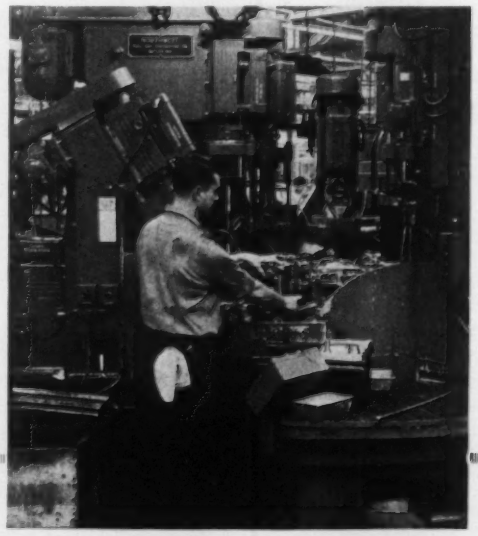
An important consideration in the application of a pneumatic cylinder with meter-out flow controls is the type of force buildup which is available at the piston rod for accomplishing useful work. The output force of a pneumatic cylinder, unlike that for a hydraulic cylinder, increases gradually with respect to time, *Fig.* 16.

single tool lubricant serves multioperation machine

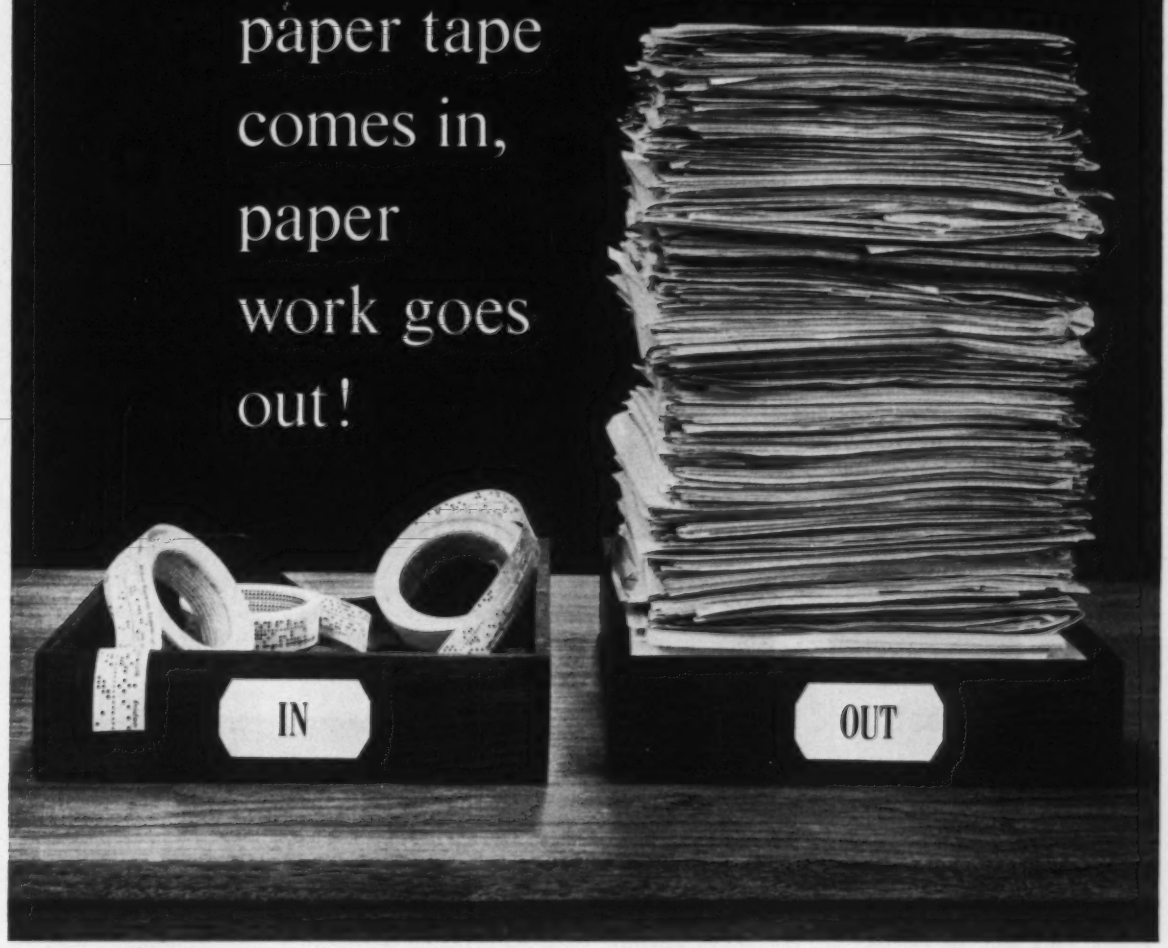
SELECTION of a single tool lubricating compound to handle several different types of cutting operations on a multistation production machine may require considerable trial and error experimentation unless a practical system of lubricant analysis and elimination is used. Conceivably, different cutting operations could require basically different lubricants to obtain maximum performance characteristics while the machine is provided with only one lubrication system. Such a problem faced engineers of Evinrude Motors Div., Outboard Marine Corp., when they were installing a new 8-station dial indexing machine built by Northwest Tool and Engineering Co.

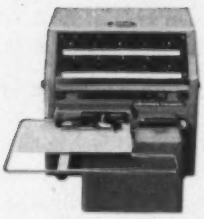
The machine was procured to perform 29 machining operations on connecting rods for outboard motors. The tools used on the machine include 19 drills of which one ¾-inch drill turns at 12 rpm, two core and four chamfer drills turn at 900 rpm, one step and four straight drills turn at 1200 rpm, and seven straight drills turn at 1800 rpm; two 5/16-24 interrupted thread taps; two 7/16-inch spot facers at 600 rpm; four ⅜-inch end mills at 900 rpm; one pin reamer at 300 rpm; and one bore reamer at 180 rpm.

The connecting rods were machined from a 4620 steel forging, normalized to Rockwell C-10. This hardness and structure made it possible to consider water soluble compounds. Evinrude engineers selected a compound manufactured by Van Straaten Chemical Co. that had been performing satisfactorily on a similar tooling setup and tried the compound at a heavy concentration of 5 to 1 since they wanted maximum lubrication to prevent welding and poor finish on the taps. This compound proved satisfactory and further tests showed that the concentration could be reduced to 10 to 1. To further prove their results, the engineers removed the selected compound from the machine and replaced it with another water soluble compound that had produced excellent results in various drilling operations. However, this compound caused a buildup on the taps and created a finish problem.



Collectadata: when paper tape comes in, paper work goes out!





The machine at left is a Friden Collectadata® Transmitter, key to a new system of internal data collection that virtually eliminates in-plant paperwork.

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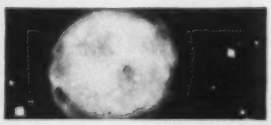
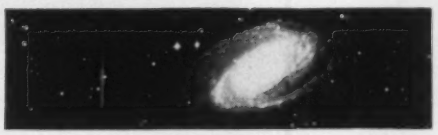


Bell Laboratories research with chilled ruby amplifiers speeds the day we may telephone via satellites



A strange combination of Nature's forces at Bell Laboratories foreshadows the day when world-wide phone calls may be relayed via man-made satellites orbiting the earth. It is a union of synthetic rubies and extreme cold, making it possible to amplify microwave signals from these satellites clearly.

Synthetic rubies possess an extraordinary property when deeply chilled and subjected to a magnetic field. They can be excited to store energy at the frequencies of microwave signals. As a signal passes through an excited ruby, it releases this energy and is thus amplified a thousandfold.

Bell Laboratories scientists chose a ruby amplifier because it's uniquely free of "noises" that interfere with radio signals. For example, it doesn't have the hot cathodes or hurtling electrons that generate noise in conventional amplifiers. It is so quiet that only the noise made by matter itself in heat vibrations remains. But at a temperature close to absolute zero, this also is silenced. Even very faint signals from satellites can be clearly amplified and studied for their possibilities.

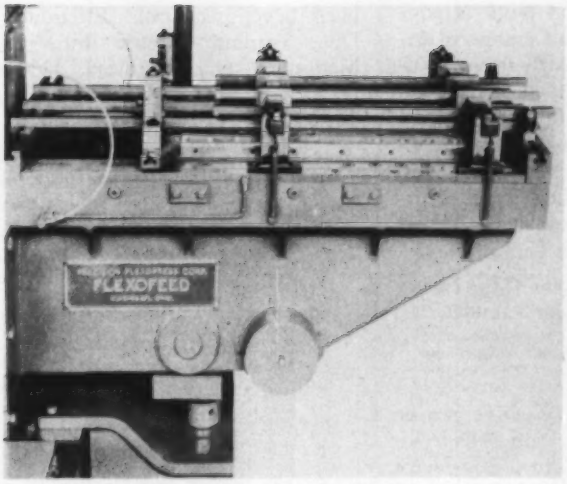
Bell Laboratories scientists were first to discover that matter itself generates electrical noise. They also discovered that stars send radio waves, and thus helped found radio astronomy. It is particularly fitting that the same scientists, in their endless research on noise, should now battle this number-one enemy of telephony in the dramatic new field of communication via satellites. The ultimate goal, as always, is the improvement of your Bell System communications services.

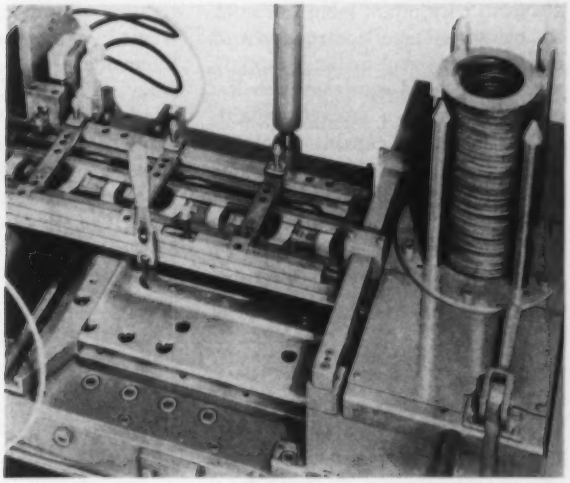
BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

AUTOMATION new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card page 35.



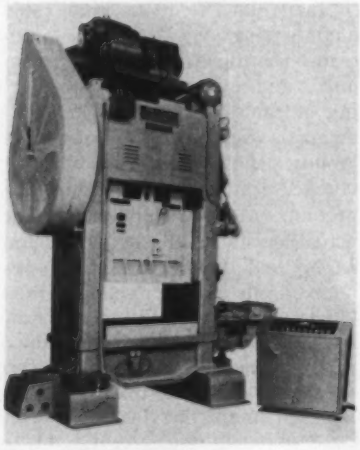


Universal feed is equipped with gripper fingers for the handling of coil stock. On some applications coil stock can be fed at 2500 inches per minute. Addition of blankholder (right) enables discrete parts to be fed to press.

Blank and Coil Strip Feeder

DEVELOPED by **Precision Welder and Flexopress Corp.**, 3520 Ipsen Ave., Cincinnati, Ohio, this feed unit is designed to feed cut blanks and coil strip interchangeably. Designated as Flexofeed, it is capable of handling a wide range of feed lengths and speeds with accuracy down to ±0.002. On some applications, coil stock can be fed at 2500 inches per minute. Blanks can be fed at rates up to 300 per minute. Adjustment from coil stock to blanks (round or irregular) is made by attaching a blankholder to the top of the feed. The basic structure of the unit remains permanently mounted to the press. It is adjustable for strip up to the full width of the press opening and for feed increments as short or long as desired. Designed as a standard optional component, the feed is built for use with high-speed Flexopresses that use conventional dies. It leaves the die area completely clear so that changeover from one part to another, including die change, can be quickly accomplished. Conventional tool design for forming and blanking at high speeds can be used without modification.

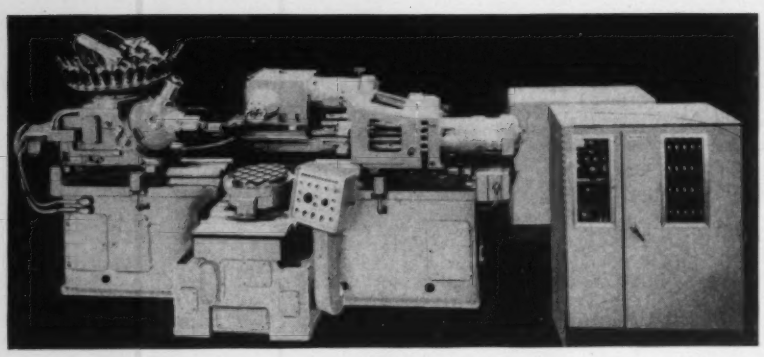
Circle 401 on Page 35



Flexible feed mechanism is a standard optional component, built for use with high-speed Flexopresses. It is designed specifically to keep presses running at top productivity.

Machine Tool System

Tape controlled machining center has been specifically designed to automate job-lot production. It will perform machining work on a large variety of parts in sizes up to that containable within a 12-inch cube. Manufacturing lot quantities in the range of 5 to 500 parts are particularly well suited to production with the MT-3. This three-station machine has independent spindle drive motors, each with 5 to 7½ horsepower capacity. Designed on the



building block principle, unit has a central positioning table surrounded by three tape controlled work heads: A universal drilling, tapping, and boring head equipped with tool changer having a storage capacity for 30 tools and capable of changing tools in less than three seconds; a face milling head; and an optional multiple spindle drill head or a precision boring head with a 14-tool capacity changer. An electronic numerical control system directs operation of the unit. Work is positioned in relation to cutters in increments of 0.001 inch to an accuracy of ±0.0005 inch. Transposition of engineering information from drawing to control tape is accomplished on a tape preparation unit. **Industrial Systems Div., Hughes Aircraft Co.**, P. O. Box 90904 Airport Station, Los Angeles 45, Calif.

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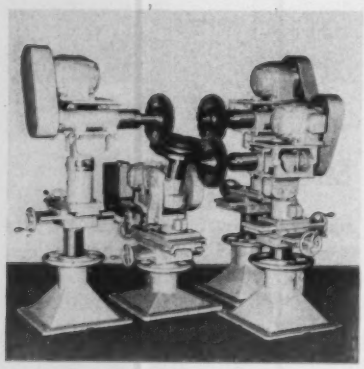

Deburring Machine

Semiautomatic deburring machine is used for finishing circular parts or those of related shape. Gears and sprockets, motor rotors, stators, and a wide assortment of stampings are ideally suited to finishing on this unit. The machine consists basically of an adjustable single spindle type B-61 semiautomatic unit that positions and rotates the parts, and three L-8-L adjustable lathes positioned to perform the deburring operations. The spindle of the machine can be tilt adjusted between the vertical and horizontal to permit proper part positioning for different deburring applications. The machine can be adjusted in the forward or side directions or pivoted in a 360-degree arc to permit easy location of the part with respect to the lathes. Spindle speeds vary from 1000 to 2100 rpm. Wire brushes, abrasive disks, tampico brushes, and abrasive wheels can be mounted on the lathes to perform the deburring operations. **Acme Mfg. Co.**, 1400 E. Nine Mile Rd., Detroit 20, Mich.

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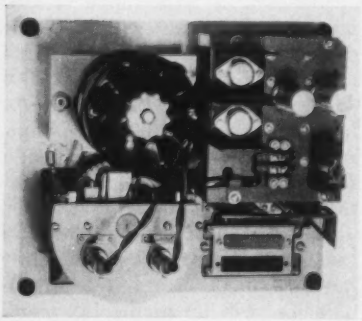

Block Reader

Model 290 block reader has been designed to read simultaneously 8 characters in perforated tape (up to 12 characters on special request) in order to reduce or eliminate data storage and switching circuits. Applications include checkout and inspection systems, machine tool numerical control systems, and storage system program loading and checkout. Tape is driven from left to right by a drive drum and punch roller. An electronically controlled electromagnetic brake and clutch system, integrated with the tape drive assembly, permits block by block, or character by character tape advance. Sprocket hole reading of only the first and last characters of a block provides information for block advance control. **Electronics Div., Ferranti Electric Inc.**, 95 Madison Ave., Hempstead, L. I., N. Y.

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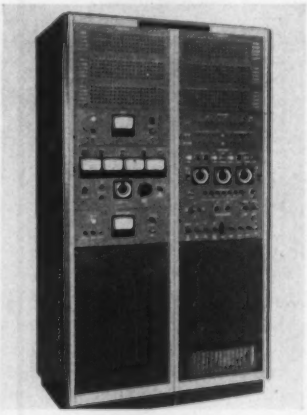


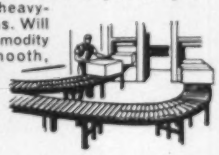
Circuit Analyzer

High-voltage circuit and cable analyzer has been built for automatic continuity, insulation resistance, and dielectric strength testing of cables with up to 120 conductors. Conductors are tested in groups; each group in turn is checked against all other groups and ground. Model 8524 measures the actual resistance of each conductor. Lower and upper acceptable resistance limits are presetable from 0.5 to 200 ohms. Either ac or dc hypotting (high voltage breakdown testing) may be selected. Test voltage is adjustable from 0 to 5000 v. Maximum acceptable leakage current is adjustable from 1 microampere to 2½ ma on dc, or 0.5 ma to 3 amp on ac. Insulation resistance measurements are made at the standard 500 v test potential, with minimum acceptable limit ad-

SIXTEEN ways to cut your costs with Standard Conveyors

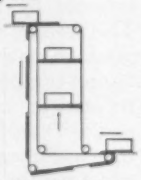
1. Gravity Roller Conveyors

For rolling away your high handling costs using the free power of gravity. Widest range of styles, widths and lengths for light, medium and heavy-duty applications. Will carry any commodity having one smooth, firm surface. Carrying capacities from 35 to 8,000 lbs. per roller.



2. Vertical Conveyors

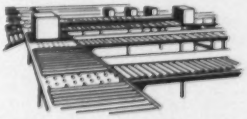
New "Escaveyor" loads itself, unloads itself, lifts 10 cartons per minute with speed and continuity of a belt. Needs only 12 sq. ft. of floor space, costs less to buy than many other types of lifts. Investigate! Conventional reciprocating lifts and tray-type lifts are also available.



How Escaveyor operates.

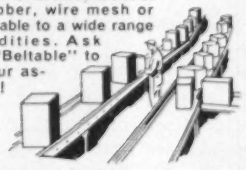
3. Live Roller Conveyors

Choose Standard's powered rollers for completely automated conveying. Ideal for abrasive materials such as castings and heavy boxes. Many styles, widths and carrying capacities.



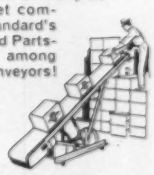
4. Belt Conveyors

Horizontal, inclined, declined—or a combination of all three. Belts of canvas, rubber, wire mesh or steel. Adaptable to a wide range of commodities. Ask about the "Beltable" to simplify your assembly work!



5. Portable Conveyors

Cut costs of loading, unloading, elevating, stacking and piling—even of many assembly operations. Get complete information on Standard's Handibelt, Handipiler and Partsbelt—the "Big Three" among cost-cutting portable conveyors!



Portable Handibelt is easily adjusted to wide range of inclined, declined or horizontal conveying jobs.

6. Pneumatic Tube Systems

Expedite your in-plant communications—provide swift, sure, safe transportation of engineering drawings, messages, samples and parts with "air" transportation. Cylindrical or oval carriers. Completely automatic or semi-automatic systems available.

7. "Do-It-Yourself" Conveyors

Save up to one-third the cost of your next conveyor with "off-the-shelf" ordering and "do-it-yourself" installation. Handidrive Conveyor Handbook describes all the components you normally need and tells how to use them. Cut your costs! Send for this valuable Handbook today!

8. Spiral Chutes and Slides

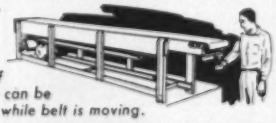
Down go costs when you install a spiral chute to lower cartons, cases, sacks and similar commodities. Closed or open types for virtually any height and from 12" to 66" in width. Also available in stainless steel.

9. Dish Tray Handling Systems

The efficient, compact and economical way to handle trays of soiled dishes. Available with automatic loading and unloading. A wide range of kitchen and cafeteria conveyors also available. Send for Traylift/Traybelt catalog.

10. Truck Loading Conveyors

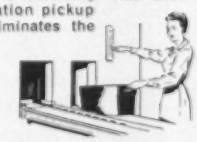
Cut loading and unloading costs with Project-O-Veyor, Standard's labor-saving extendable conveyor. Now available in either stationary or portable models and with either manual or push-button boom controls.



Length of conveyor can be changed while belt is moving.

11. Mail and Record Handling Systems.

A Standard Recordlift System cuts the cost of distributing mail and other material in multi-story buildings with push-button speed and efficiency. Has automatic, multi-station pickup and delivery. Eliminates the need for inter-floor messengers. Write today for Recordlift bulletin.

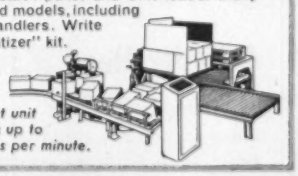


12. Wheel Conveyors

Highly useful because of their low cost, light weight and ability to operate at minimum slope. Wheels available in many sizes and styles mounted in two, three and four-rail frames. Aluminum or steel.

13. Carton and Case Stackers and Unstackers.

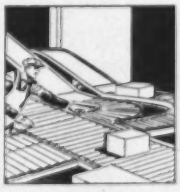
Save handling costs by reducing man-hours needed to stack and unstack pallet and unit loads. Many standard models, including pallet handlers. Write for "Unitizer" kit.



Compact unit unstacks up to 45 cases per minute.

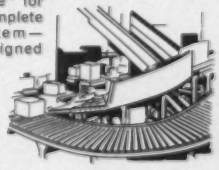
14. Warehouse Storage and Sorting Systems

Where commodities must be sorted quickly and stored systematically, a modern conveyor system can do much to reduce your costs. Designing such systems has long been a Standard specialty. Write for particulars.



15. Custom Engineered Conveyor Systems.

More than 50 years of experience makes Standard Conveyor a logical "first choice" for quoting on a complete conveyor system—specifically designed to cut YOUR handling costs. Inquire today for details!



Standard Conveyor COMPANY

Sales and Service in Over 40 Cities
Look in your Yellow Pages under "CONVEYORS"

The Sixteenth Way? Inquire today for literature. Simply circle the appropriate numbers below, sign your name, clip the coupon and attach it to your letterhead. Mail it to Standard Conveyor Co., 303-8 Second St., North St. Paul 9, Minn.

YOUR NAME _____

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

justable from 1 megohm to 50,000 megohms, in four ranges. **Associated Research Inc.**, 3777 W. Belmont Ave., Chicago 18, Ill.

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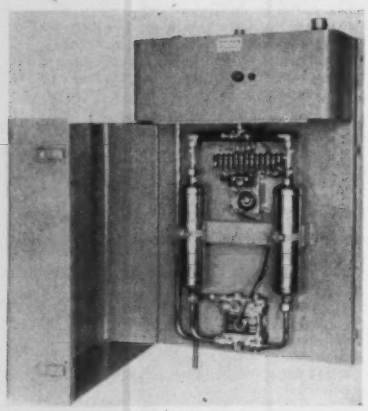

Heaterless Dryer

Device is designed for incorporation into pneumatic control systems such as used with air conditioning installations in industrial and office buildings. Up to 3.5 scfm of compressed air may be dried to a dew point of −40 F or lower with this heaterless dryer. The operating pressure range of the unit is 80 to 150 psig line pressure with saturated inlet air up to 100 F. Model MPS-5 is a dual tower device which provides continuous drying performance. While one tower is on a duty cycle, the other is reactivated by a purge of dry air. There is no heat source required. **Kahn & Co. Inc.**, P. O. Box 516, Hartford 1, Conn.

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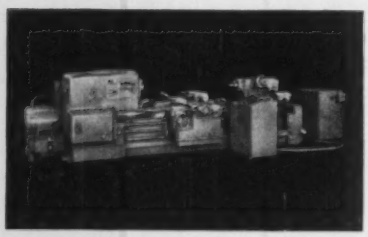

Electrohydraulic Tracer

Recommended for machining work pieces of any kind having complex contours, 360 degree, two-axis, electrohydraulic tracer system features absence of contour limitation except as might be created by a cutting tool. The Electro-Gage Tracer head utilizes a variable reactance device which sends signals to an electronic control console for interpretation and amplification. Infinitely variable feed rates are obtainable by potentiometer control. This tracing system can only be applied on new lathes at the factory. Lathes equipped with the tracer may be used for conventional operations as the hydraulic motors for driving the leadscrew and the cross feed screw can be disconnected. In such a case, the regular carriage power rapid traverse of the machine becomes operative. **Monarch Machine Tool Co.**, Sidney, Ohio.

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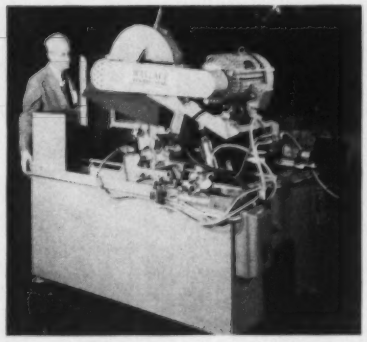

Oscillating Cutter

Cutting unit has cut up to 8-inch solid high alloy bars, with micro finish dimensions (profilometer readings as fine as −32). It cuts at a rate of from 4 to 10 seconds per square inch depending upon the character of the material being cut. An external and separate supply of coolant is pumped through a three-way coolant distributing system at the rate of up to 45 gallons per minute. Oscillation is made possible by Bellows air motors with hydraulic check. It can be very slow or at speeds up to 100 strokes per minute, infinitely variable. Length of stroke can be adjusted from $\frac{5}{8}$ to 6 inches. Designated as Oscilla-Modular Series 1520 A60 this cutter is currently available in five sizes—16, 18, 20, 26, and 34-inch wheels. Oscillation for wet cutting of work in sizes $2\frac{1}{2}$-inch diameter and larger is mandatory. **Wallace Supplies Mfg. Co.**, 1300 Diversey Parkway, Chicago 14, Ill.

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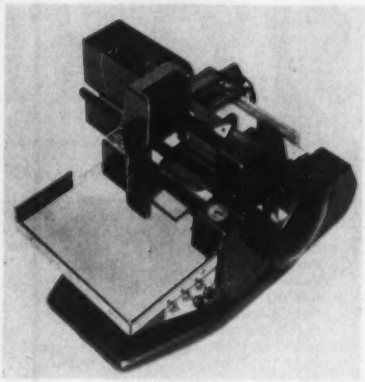
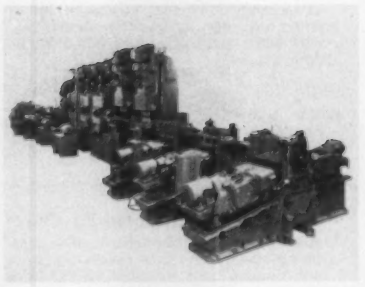


Punched Card Reader

High-speed card reader is capable of handling standard $7\frac{3}{4}$ by $3\frac{1}{4}$ inch cards with rectangular or round holes, 80 or 45 columns. It is designed for direct application to data systems as a card transport and includes only circuits directly associated with its performance. Standard unit has a capacity of 600 cards with a maximum feed rate of 400 cards per minute. Larger capacity hoppers are available. The output signals are from phototransistors providing +9 volts for *No Punch* and −10 volts for *Punch*. Unit is available in five different models. **Genesys**, 10131 National Blvd., Los Angeles 34, Calif.

Circle 409 on Page 35



Cylinder Head Machine

Twenty-two station transfer machine with 81 spindles has been built for machining automotive cylinder heads. It drills, gun drills and bores, taps, and spotfaces. Production is 130 parts an hour at 100 per cent efficiency. Gun-drilling spindles drill and bore the valve-guide holes. Each of the gun-drilling spindles is inside another spindle which has a separate feed and speed.

ELIMINATE UNNECESSARY ASSEMBLY COSTS with

Replace improvised units with readily available precision cam followers.

McGILL®

CAMROL® BEARINGS

CF (Cam Follower) SERIES

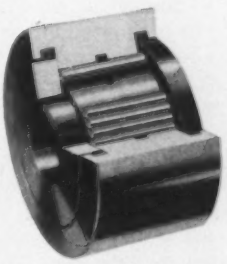
The original and still unsurpassed anti-friction roller bearing cam-follower bearing that adds efficiency at less cost to cam actuated, track and support roller applications. Built with full roller complement and integral stud, the CF series design provides high radial capacity and shock load protection in a compact roller with its own shaft. Easily applied and available in roller diameters of ½" to 4".

for the ultimate in:

- RADIAL CAPACITY
- SHOCK RESISTANCE
- SPACE ECONOMY

SCF SERIES.

Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.



SCYR SERIES (sealed)

CYR (Cam Yoke Roller) SERIES

The CYR series increases the adaptability of the CF bearing to all types of automatic machinery involving cam action or controlled-motion machine parts that require guide or support rollers. An inner ring replaces the stud for cam yoke roller mountings.

Write for Catalog No. 52-A for full information on McGill's needle roller bearings, and cam followers. Ask about recommendations for high precision special ball and roller bearings.

SCYR SERIES

This series provides a fully sealed Cam Yoke Roller type bearing. It is dimensionally interchangeable with the CYR bearings.

McGILL MANUFACTURING CO., INC., Bearing Division
401 N. Lafayette Street, Valparaiso, Indiana

engineered electrical products

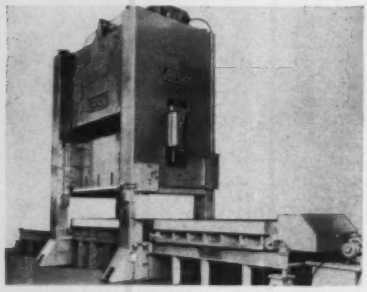
McGILL®

precision needle roller bearings

Circle 690 on Page 35

Cutters mounted on the outer spindles bore and surface valve seats. All of the machining heads are mounted on cylindrical ways. Drilling, boring, and spotfacing spindles have hydraulic feed; the tapping spindles are equipped with lead screws. Spray lubrication is provided for all taps. The machine is designed throughout using standardized components. Chips and coolant drop through to an under-the-floor conveyor. There is a roll over at the exit end of the machine. Electrical circuitry of the machine is set up so that three stations can be bypassed for running service parts. A probe station located just before the tapping station makes sure that there are no broken drill ends in the holes. **Foote-Burt Co.**, Cleveland 8, Ohio.

Circle 410 on Page 35



Moving Bolster Assembly

Assembly has been developed to cut die change time. It can be furnished as either a single moving bolster unit or a double bolster unit (illustrated). In a single unit, the bolster is mounted on a self-contained traction unit which moves on trolley type wheels over tracks on a table extending from one side or the other of the press. The traction unit is driven by a dc motor and separate gear reducer which is designed to slow the motion of the bolster as it approaches the positive stops. Double units utilize extension tables on both sides of the press. Two traction units with bolsters are connected in tandem. When one bolster is in pressing position the other bolster is on the extension table where tooling changes can be made. **Verson Allsteel Press Co.**, 9300 S. Kenwood Ave., Chicago 19, Ill.

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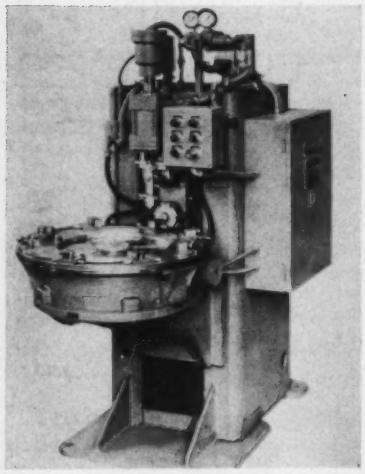

Dial Indexing Welder

Conventional Acromatic dial indexing unit has been applied to production operation involving manual loading of two small transistor case halves, ring projection welding, and automatic ejecting. Welding head is low inertia antifriction linear ball bearing diaphragm type with selective deflection firing. Eight-station indexing table is Geneva motion motor driven with electric clutch brake. **Acro Welder Mfg. Co.**, 1719A W. St. Paul Ave., Milwaukee 3, Wis.

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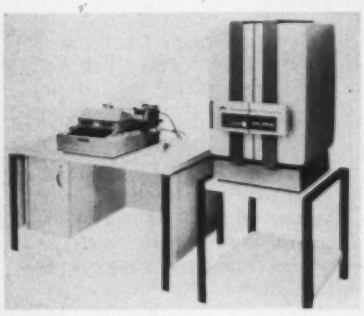

Digital Computer

Ultrafast general purpose digital computer can be applied to an extremely broad range of scientific and industrial problems. It combines a large, expandable memory and a versatile command structure with computing speed in the microsecond range. Model PB250 computer is qualified for either on-line or off-line applications. These applications include use as an engineer's desk-side computer and also as an on-line computer for process monitoring, process control, data-logging, and alarm generation. It is a serial, binary, single-address computer with an internally stored program. Features include: Micro-second speed; expandable memory; versatile command structure; and simple programming. Floating point operations with a 37-bit mantissa and a 7-bit characteristic require less than 3 milliseconds. Internal memory of 1808 words is expandable to 15,888 words. An additional 16,834 words of core memory are available. The computer is ideally suited to serve as the central element in a number of devices that are presently treated as special-purpose systems. It can be programmed to check its own operation and to monitor the operations of the remainder of the system. Standard equipment includes an automatic typewriter with paper tape reader and punch. **Packard Bell Computer Corp.**, 1905 Armacost Ave., Los Angeles 25, Calif.

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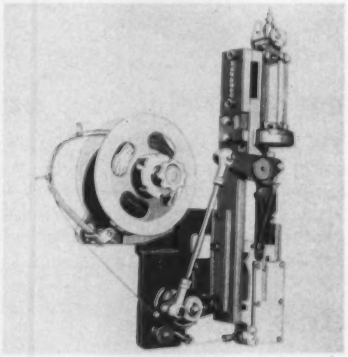
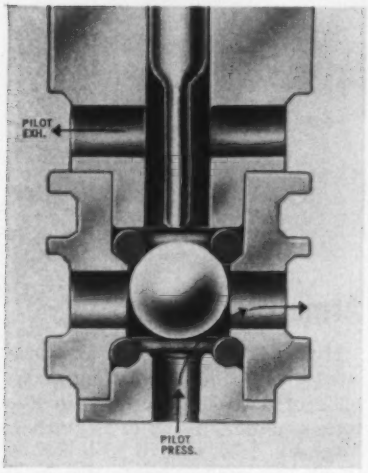


Stapling Head

Unit is suitable for independent mounting, horizontally or vertically, on a base or frame. It is used for stapling wood, plastic, fibre, paperboard, etc. Applications include the fastening of furniture parts, crates, boxes, toys, millwork, and prefabricated home and trailer parts. The unit instantaneously cuts, forms, and drives its own staples direct from coils of standard wire. It is driven by a pneumatic cylinder. Heads may be fitted to produce staples from 1/4 to 1-inch maximum width, or from 3/8 to 1 1/2 inches

(Advertisement)

How To Build An Air Valve That Beats Friction and Coil Heat



ENLARGED SECTION OF PILOT CARTRIDGE

To Achieve Endurance, a Breakthrough in Speed

Generally, the most unpredictable factor in solenoid valve life is the solenoid coil itself, and yet, a solenoid can be made to last practically forever if the coil can be kept from overheating. Coil heat is generated by long plunger travel and accelerated by erratic drag (friction) during that travel. Achieve a short, quick, sure plunger stroke and the coil will last indefinitely. Therefore, the life of a solenoid pilot air valve is directly related to speed of operation. To achieve operating speed, friction in the pilot section and solenoid plunger travel must be reduced to a minimum. Solve these problems and you get air control reliability that seems to have no limit.

The Call-Outs Tell the Story of Endurance

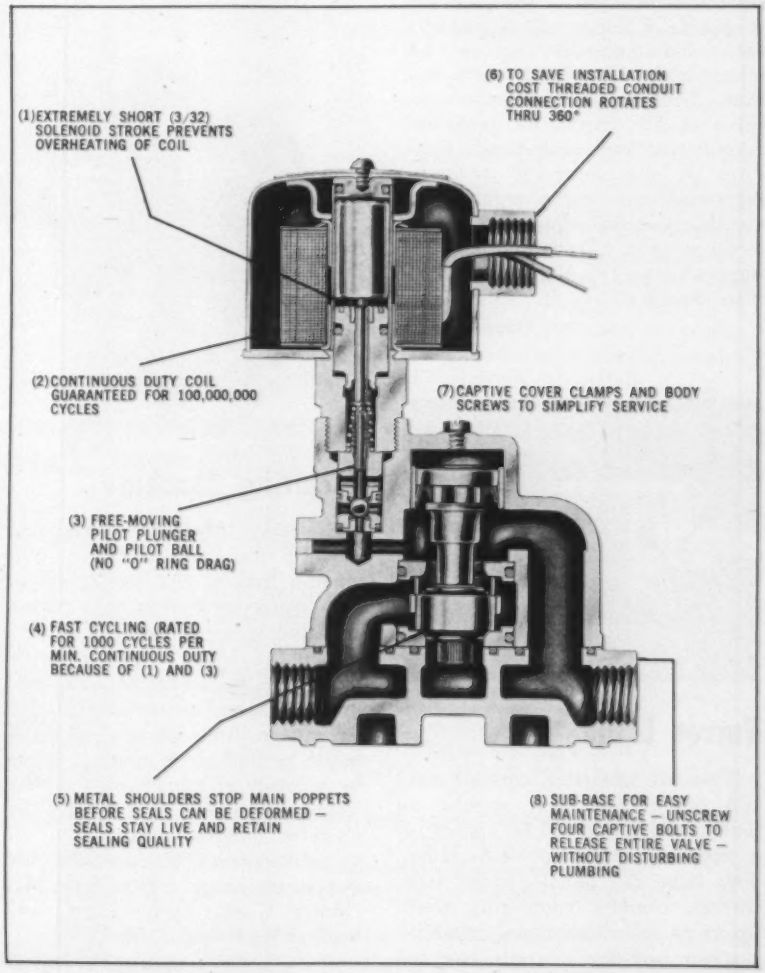
To control the major source of coil burnout, coil heating, the stroke of the solenoid plunger must be reduced to a minimum. The short stroke fractions the time the coil is energized; heat generation drops and response time of the valve is stepped up. In the "Mach 2" the stroke has been reduced to 3/32—about the thickness of a nickel. Furthermore, the friction problem must be solved, to avoid any unpredictable drag. In the "Mach 2" this has been done by use of a pilot cartridge enclosing a free-moving ball that seats on "O" rings at both ends of the cartridge [see above]. The ball moves freely, independent of the seals. There is no "O" ring drag on the pilot plunger as it requires no seals. When there is no friction there is no wear. Similarly, the main valve seats seal on "O" rings. In the sealed position, metal shoulders take the shock in such a way that the "O" ring seal is merely kissed by the main valve seat [see (5) below]. As the rings are only minutely flexed they do not fatigue or lose their resilience.

What about Cycling Speed?

Short solenoid plunger stroke and elimination of friction make extremely fast cycling feasible. After exhaustive testing in the laboratory and on industrial applications for over six years the "Mach 2" is rated at 1000 cycles per minute continuous duty. Cycling speeds as high as 2100 have been successfully reached for intermittent periods of twenty minutes. During a two-hour test at a sustained speed of over 1500 cycles per minute the coil temperature stabilized at 7°C below the maximum code limit for Class A coils.

100-Million-Cycle Guarantee on Solenoid Coils

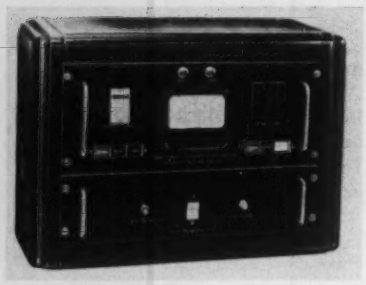
The design advances incorporated in the CRESCENT® "Mach 2" Air Valve are a significant breakthrough in both cycling speed and operating dependability. Put CRESCENT® "Mach 2's" (¼- to ¾-inch pipe sizes) on your "valve killer" jobs and see how freedom from coil burnout helps to cut operating costs. Write for an advance copy of the new CRESCENT® "Mach 2" catalog to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, Calif.


(1) EXTREMELY SHORT (3/32) SOLENOID STROKE PREVENTS OVERHEATING OF COIL
(2) CONTINUOUS DUTY COIL GUARANTEED FOR 100,000,000 CYCLES
(3) FREE-MOVING PILOT PLUNGER AND PILOT BALL (NO "O" RING DRAG)
(4) FAST CYCLING (RATED FOR 1000 CYCLES PER MIN. CONTINUOUS DUTY BECAUSE OF (1) AND (3)
(5) METAL SHOULDERS STOP MAIN POPPETS BEFORE SEALS CAN BE DEFORMED — SEALS STAY LIVE AND RETAIN SEALING QUALITY
(6) TO SAVE INSTALLATION COST THREADED CONDUIT CONNECTION ROTATES THRU 360°
(7) CAPTIVE COVER CLAMPS AND BODY SCREWS TO SIMPLIFY SERVICE
(8) SUB-BASE FOR EASY MAINTENANCE — UNSCREW FOUR CAPTIVE BOLTS TO RELEASE ENTIRE VALVE — WITHOUT DISTURBING PLUMBING

Circle 691 on Page 35

for length of staple leg. Heavy duty staples will penetrate materials to a total thickness of 1⅜ inches allowing for clinch. **Saranac Machine Co.**, Benton Harbor, Mich.

Circle 414 on Page 35



Circuit Tester

High potential circuit tester has been developed for detecting high resistance leakage breakdown, arcing or shorting on electronic control circuits of all types. Model T-660 is capable of testing 167 related circuits simultaneously against all others or one nonrelated circuit at a time. Unit can be expanded in multiples of 56 circuits for programming to customer requirements. Features include automatic advancement from one circuit to another and variable peaktime adjustment from 1 to 60 seconds. **Trans-America Dynamics Corp.**, 149-A Babylon Turnpike, Roosevelt, L. I., N. Y.

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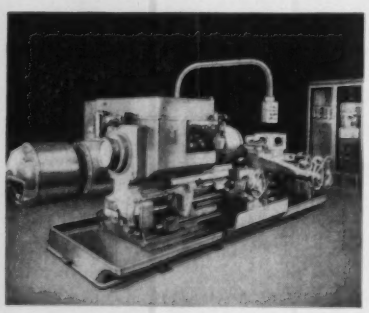

Turret Lathe

Two-axis, numerical contour control system has been applied to both carriage and saddle aprons of a cross-sliding turret 4-A lathe. This lathe can handle, under tape control, complex contouring work up to its full dimensional capabilities. In addition to contouring irregularly shaped surfaces, the numerical contouring system also can be used for straight-line cuts and taper cuts of any angle. The tape selector switch, starting switch, and related slide positioning controls are located on an overhead pendant control station projecting from the rear of the lathe. The electronic system used with this machine is digital and incremental in nature with input of recorded information supplied by standard 1-inch wide punched tape of Mylar or Mylar-aluminum laminate. A standard typewriter with a tape punch attachment is used for tape preparation. Use of punched tape for the contour control is designed to eliminate metal template making and storage problems as well as to remove the dimensional restrictions common to most tracer duplicating attachments. **Warner & Swasey Co.**, 5701 Carnegie Ave., Cleveland 3, Ohio.

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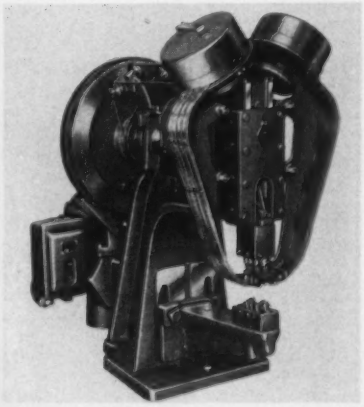

Eyeleting Machine

Eyeleting Machine, designated Model F, has achieved complete automatic feeding and setting of six twin connector eyelets in a plastic insulating terminal board. The 3/16 inch plastic board is approximately 2½ by 1½ inches in size. Eylets are in six pairs, and are set in an irregular pattern. Automation of terminal board production is made possible by accurate alignment of a special setting bar and a rigid frame that provides uniform pressure on all six twin contact points scattered over the pattern range. **United Shoe Machinery Corp.**, Eyelet Dept., 140 Federal St., Boston 7, Mass.

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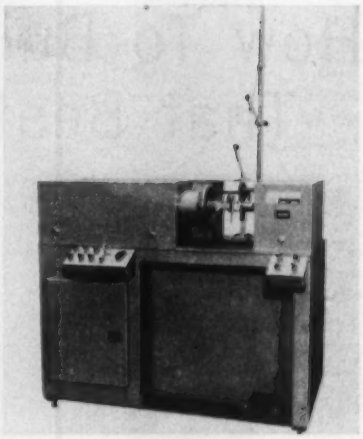

Armature Winder

Hydraulically controlled armature winder is capable of handling armatures of diameters from ½ to 2½ inches and lengths up to 3¼ inches. After the lead wire is attached, a simple pushbutton starts the automatic winding and hook-up cycle. Correct winding speed, up to 3000 rpm, can be set on control panel. A hydraulic pump unit with variable volume and pressure (10 gallons per minute, 1000 psi maximum and 20-gallon reservoir) powers the entire unit. **Possis Machine Corp.**, 825 Rhode Island Ave. South, Minneapolis 26, Minn.

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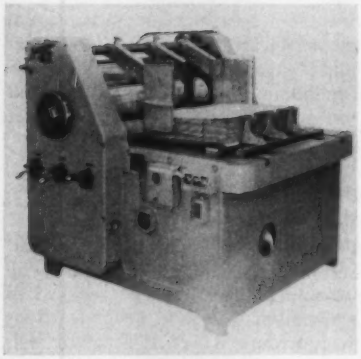
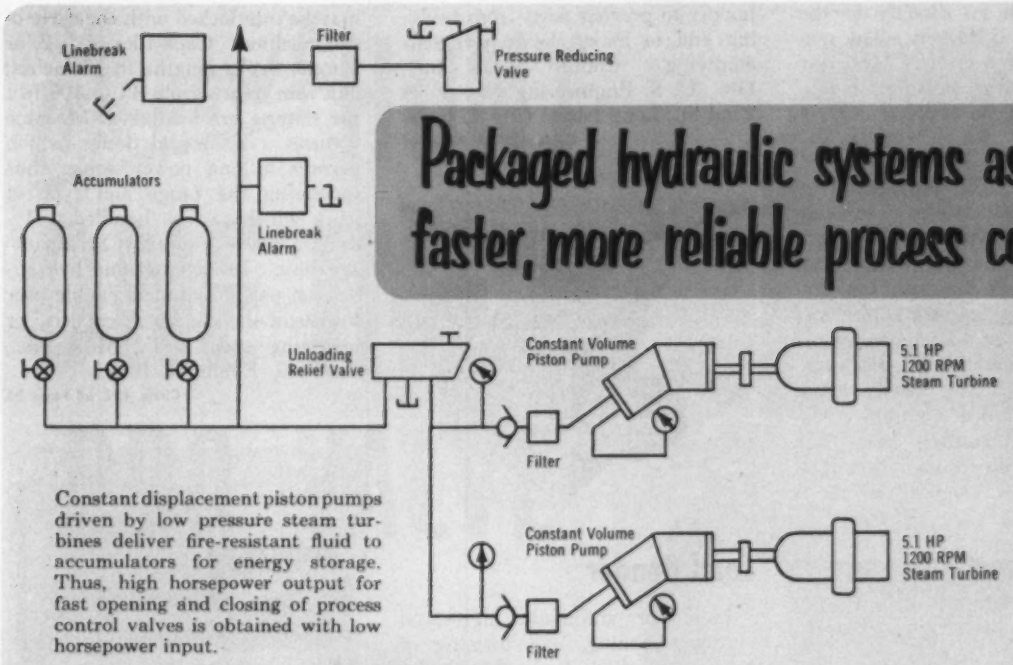


Container Printer

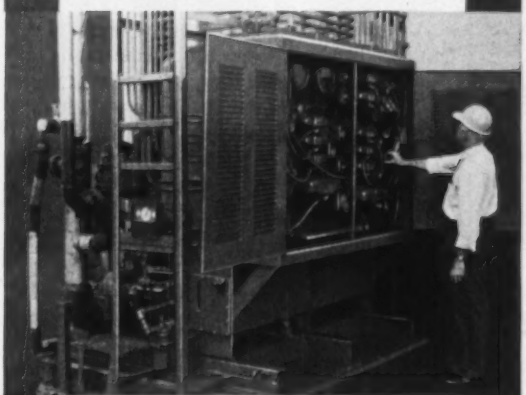
Device is designed to print knocked-down corrugated containers after the manufacturer's joint has been secured. Designated Model KDF, it is only about one-half as wide as a printer-slotter. Due to the printer's quick drying ink action, printed boxes can be handled as soon as they come off the ma-

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

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DIVISION SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1536 • Detroit 32, Michigan

9138

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chine and can go directly to the shipping dock if desired. The machine can be fed directly from any type of container finishing equipment and can be supplied with a counter-ejector which counts and stacks the boxes as they come off the machine. The unit prints in one color all panels on the top side of a knocked-down container. It is also available in a model which can print all panels on both top and bottom. Other features of the machine include an automatic hopper feed, variable speed drive, and register adjustment. Ink distribution is precisely controlled. **Container Machinery Div., Bostitch Inc.**, 2018 Briggs Drive, East Greenwich, R. I.

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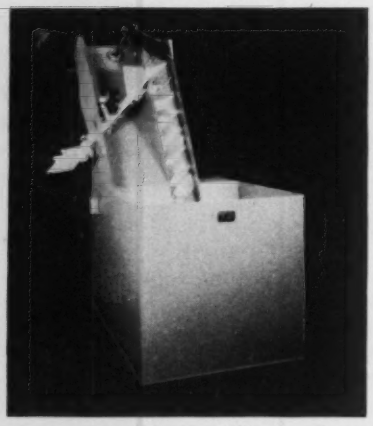

Elevator Hopper

Items that can be oriented, fed, or counted with this standardized general purpose hopper include paper tubing, metal tubes, cylindrical objects, plastic vials, collars, nuts, bolts, bottle caps, toy hardware such as hub caps, bicycle pedals, hand grips, pipe fittings, etc. The unit is equipped with a standard adjustable track with either an escapement mechanism or a transfer mechanism to discharge cylindrical objects in a rolling position. The standard track can be quickly adjusted for a large variety of sizes and shapes. The elevator hopper has a storage capacity of approximately 10 cubic ft, with its loading opening 3 ft above floor level for the standard size. Features include a rotary brush at the top of the unit to prevent parts from carrying over, and a joggling action in the hopper to prevent parts from bridging and to make the hopper self-emptying. **Count-O-Matic Inc., Div., U. S. Engineering Co.**, 40-24 22nd St., Long Island City 1, N. Y.

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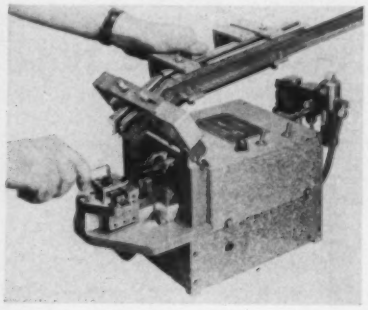

Lead Bender

Ideal for automatic high-speed cutting, bending, and forming of resistor and diode leads, this bender features an adjustable card feed chute for rapid loading of components, stellite tipped cutters, adjustable speed, and an air filter regulator lubricator. It has been designed especially for the preparation of components for printed circuit boards. Special attachments include a hopper feed, taped reel feed, lead clamps, and heat sink stress relief shapers. **Design Tool Co., Div., Federal Manufacturing & Engineering Corp.**, 1055 Stewart Ave., Garden City, N. Y.

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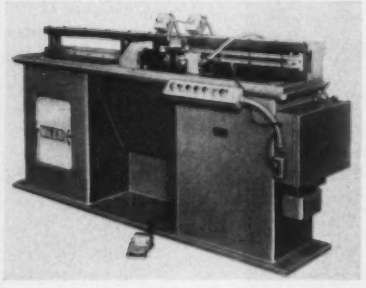

Broaching Machine

Horizontal broaching machine is designed for precision external or internal broaching on a high production basis. It is also ideal for short run jobs. This completely self-contained unit can accept simple tooling or fixtures which may be interlocked with the cycle of the machine. Capacities of 1, 2, or 3 tons; stroke lengths to 72 inches; and ram speeds from 40 to 100 feet per minute are available. Machine features a horizontal design which permits a long power stroke thus increasing the range and type of work which can be handled. Hydraulic power is supplied by a package unit. Interchangeable hydraulic ram power cylinders enable user to extend the machine's capacity or operating speed. **Ty Miles Inc.**, Box 446, Elmhurst, Ill.

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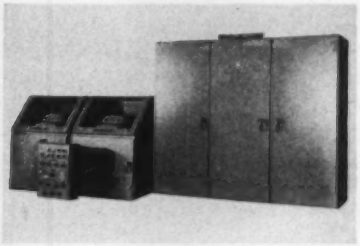
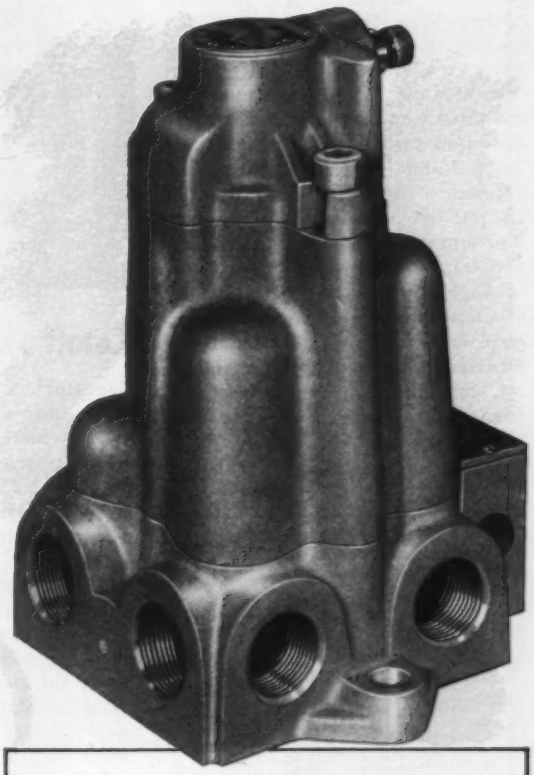


Data Accumulator

This system has been developed to automatically accumulate, record, and print deviations in the quality of tinplate coils. It has been designed so that it makes use of the existing sensing stations at the steel plants where it has been installed as part of the processing lines. Deviations in the predetermined characteristics of every coil of tinplate manufactured in a production run are automatically recorded on printed forms. The system includes a visual inspection station; a main cabinet which contains three independent computers, a comparing circuit, and a trouble indicator; and an output cabinet together with interconnections to existing sensing gages on the electrotinning line. It uses four standard types of logic plates, together with magnetostrictive lines that store the total number of feet of each type of defect, and also provide the necessary delay between the time that a defect relay operates and the time that the defect reaches the shear. Designed to prevent errors from originating within the system and to provide reliable uninterrupted operation, this system includes three identical computer sections operating in parallel. The answers from the com-

It's new! HUNT ONE INCH PDQ VALVE



Cylinder ports front, side and bottom-tapped; supply and exhaust ports side and bottom-tapped; basic 1 in. PDQ available tapped ¾, 1 or 1¼ in. NPT (also basic ½ in. PDQ tapped ⅜, ½ or ¾ in. NPT); for air or vacuum service, pressures from 0 to 125 psig; meets JIC Standards.

TOPS in accessibility
TOPS in simplicity
TOPS in speed
TOPS in capacity
TOPS in quality

Now you can have all the performance-proved advantages of Hunt's PDQ center-line design PLUS the high capacity of full 1" size. The PDQ's short stroke pilot and compact, lightweight, single spindle poppet provide lightning-fast response and near-instantaneous full flow. All this in a compact package weighing only 10.8 pounds!

Look at these performance figures. The 1" PDQ, with 100 psig supply, fills a 400 cu. in. vessel to 90 psig in but 0.288 seconds (17.3 electrical cycles) . . . exhausts the same vessel from 100 to 10 psig in 0.200 seconds (12 electrical cycles) and, at 100 psig, its flow capacity is 850 cfm free air!

Downtime? Short stroke, shock-reducing all-aluminum construction and built-in wear compensation assure millions of cycles of trouble-free operation. Then, to repack, simply loosen 2 cap screws . . . twist pilot cap . . . remove pilot and valve housing. Piping is undisturbed . . . electrical connections are plug-in, wiring need not be touched.

If you're looking for better, lower cost, more dependable performance on new or existing equipment . . . before you buy any valve, be sure you see the PDQ. Call your nearby Hunt Representative today. He's listed in Sweet's Product Design File.

For more information, write for Bulletin 602. Address Dept. AU-261, Hunt Valve Company, Salem, Ohio.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

3010

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puters are compared on a two-out-of-three basis. If there is any difference in the three answers, the majority rules and the correct answer is printed out. The main sections of the three computers accumulate the data into forty registers, each having a 29-bit capacity. Binary-coded decimal is used in these sections. Output devices can be printers, typewriters, tape punches, or magnetic-tape recorders. Potential areas of application of this type of data accumulation equipment include: Steel industry, nonferrous metal industries, rubber and plastics industry, and the paper industry. **Airborne Instruments Laboratory, Div., Cutler-Hammer Inc.**, Deer Park, Long Island, N. Y.

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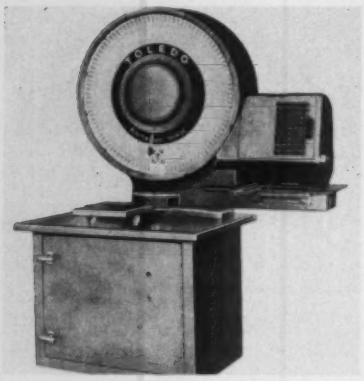

Electronic Bench Scale

Printweigh electronic bench scale extends the advantages of printed weight data to lower capacity, higher sensitivity scales. Model 9445 is equipped with a 400 series printweigh with dial capacities of 500 by ½ gram, 1000 by 1 gram, 2000 by 2 grams, or 2 lb by 0.002 lb graduations. Scale accuracy is to ±0.1 per cent of dial capacity. The scale indicator will come to rest within three seconds from the time the load is applied and the printing requires less than two seconds additional time. First developed to provide documentary weights of laboratory animals used in cancer research, the unit can be adapted to weigh almost any material in small quantities. It can be equipped to read out weight data electrically to any data recording business machine. **Toledo Scale, Div., Toledo Scale Corp.**, Toledo 12, Ohio.

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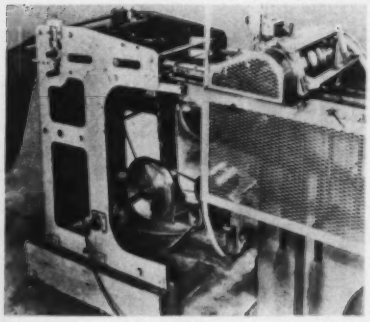

Cutoff Shear

Portable shear has been developed for cutting off metal strip while it is in motion during automatic forming operations, handling 20 gage steel 15 inches wide at up to 7000 feet per hour. Designed for operation with coil stock and therefore continuous operation, Model C-571 eliminates handling and the usual precutting operation. Space normally devoted to storing of precut lengths is also saved. Maximum stock thickness is 20 gage steel or 16 gage aluminum. Length tolerance for cut product is 0.100 inch. Feed rollers are driven with overriding clutch to permit speed differential between shear and forming machine. Power is provided by a 1 hp, 3 phase 220/440 volt motor. **Crest Engineering Co.**, 529 S. 7th St., Minneapolis 15, Minn.

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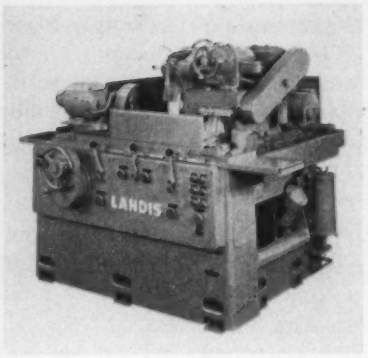

Precision Grinder

Machine is designed especially for precision work as required in missiles, aircraft, fuel injectors, and similar close tolerance parts. Ten-inch Model R universal cylindrical grinder, in addition to grinding to millionths tolerances for size and straightness, will hold pieces to within 10 millionths for roundness. A semiautomatic cycle will plunge grind to remove 0.003 inch of stock to finish size. The machine utilizes a method of grinding with ultrafine wheel feed increments controlled by a single contact gage. It has a constant reset that establishes the zone of operation for the next cycle. The grinder is equipped with live spindle headstock with plain bearings and automatic lubrication. **Landis Tool Co.**, Waynesboro, Pa.

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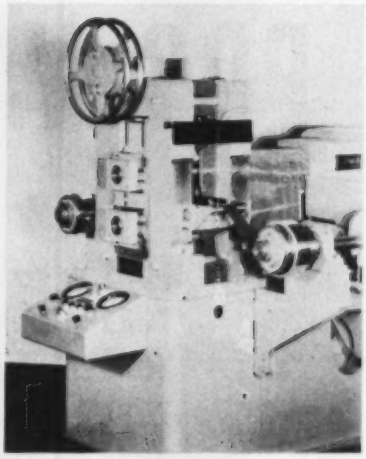
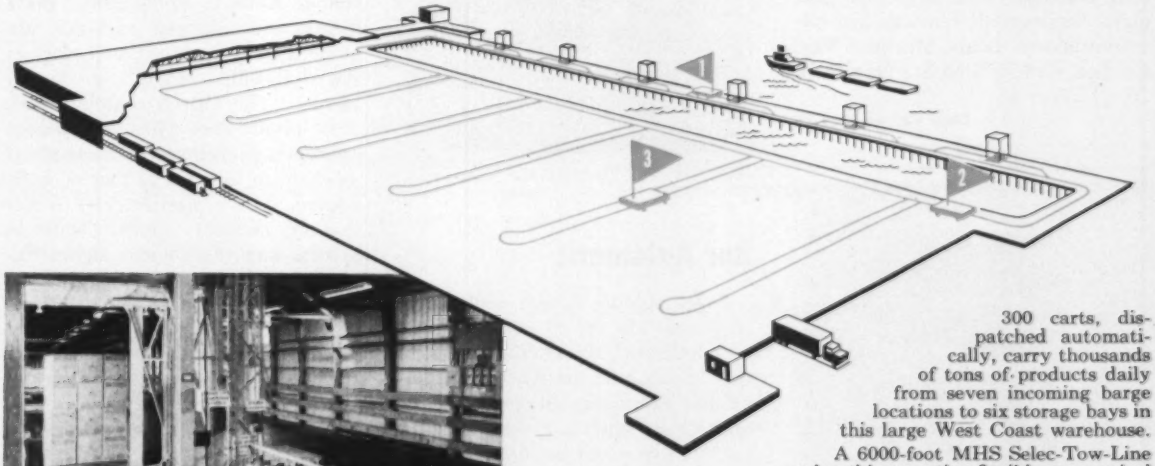
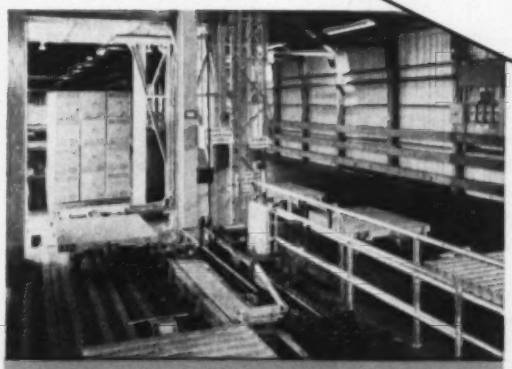


Strip Rolling Mill

Reversing cold reduction mill is designed for high-precision rolling of thin-gage ferrous and nonferrous strip with accurate front and back tension control. This 2 - high/4-high combination mill can handle up to 6-inch wide strip at rolling speeds up to 250 feet per minute. It is furnished with two sizes of 4-high work rolls, made of either alloy tool steel or solid tungsten carbide. The 1½ inch size is used for normal cold reduction down to 0.002 inch thickness, and the ¾ inch size allows special finishing to gages of less than 0.001 inch. In the 4-high setup, the machine handles up to ⅛ inch gage; the 2-high arrangement is used for the hot or cold breakdown of heavier materials up to 1 inch thick, but is also available for skin pass rolling of thin strip. Work roll changes can be made by one operator within 10 minutes, while a complete 2 - high/4-high changeover requires 30 minutes. Feature of Model 600 is its reversing strip coiling attachment

MHS Selec-Tow-Line automatically moves thousands of tons daily in huge warehouse





1 Automatic elevator (center, left) lowers carts to barge level to receive or discharge loads. Carts re-enter main conveyor loop automatically.

300 carts, dispatched automatically, carry thousands of tons of products daily from seven incoming barge locations to six storage bays in this large West Coast warehouse.

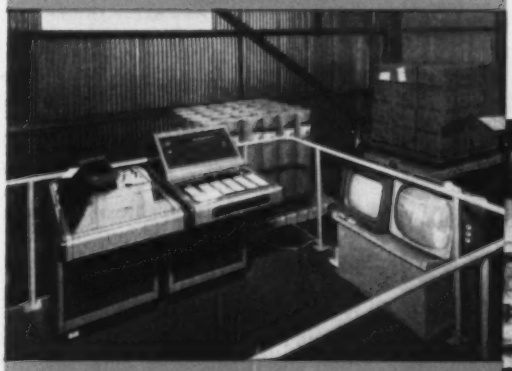
A 6000-foot MHS Selec-Tow-Line makes this operation flexible, economical and fast. Movement of materials proceeds in orderly fashion, with an easy, tonnage-consuming work pace set by the constant conveyor speed.

This MHS installation, with fully automatic elevators, switches, accumulation areas and feeder lines, reduces manpower to an absolute minimum. Closed circuit TV allows observation from the dispatcher's station.

Other MHS Tow Line installations, performing with equal efficiency and economy, are simple loops in freight terminals, and special layouts for industrial applications, merchandise warehouses and express terminals. Some are sub-floor systems, some are overhead.

Every MHS Tow Line Conveyor, whatever its length and layout, handles greater tonnage at lower cost than the system it replaced!

Call in the MHS Engineer.



2 Dispatcher sets control flag on each cart, by push-button, as it passes this station. Cart then goes automatically to its designated station.

3 Photo shows main Selec-Tow-Line with loops to storage areas leading off to left. Switching of carts is automatic. Controls are mechanical, positive, trouble-free.

MECHANICAL HANDLING SYSTEMS INC.

Manufacturing Engineers

4632 NANCY AVENUE, DETROIT 12, MICHIGAN

Factories: Detroit, Mich., Clark, N. J., Fairfield, Iowa, Windsor, Ont.

Branch Offices in Principal Cities

In Canada—Canadian Mechanical Handling Systems Ltd., Windsor, Ont.

Circle 694 on Page 35

allowing the two-way rolling of strip under tension control with no more effort than a flick of a selector switch. Machine has successfully reduced such metals as stainless steel, nickel, zirconium, platinum, and beryllium copper, as well as clad materials such as rolled gold plate, thermostatic bimetal, and silver-antimony. **Loma Machine Mfg. Co. Inc.**, 114 E. 32nd St., New York 16, N. Y.

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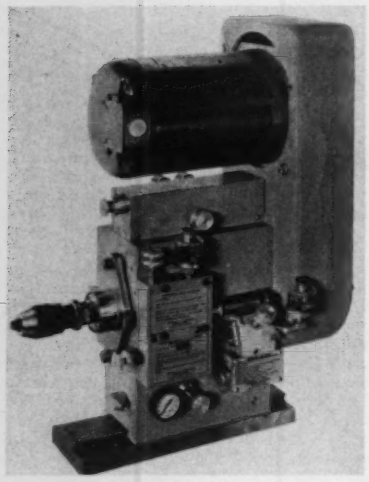
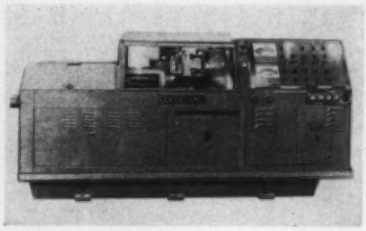


Drilling Unit

Single spindle automatic unit has been developed for drilling, tapping, threading, nut tapping, reaming, and other basic secondary operations. It may be mounted at any angle or in any position. Speeds range from 500 to 10,000 rpm. Maximum spindle stroke is 2½ inches and is adjustable down to ⅛ inch. Capacity of the unit is from 0.020 to ⅜ inch drilling and/or up to ⅜ inch tapping in mild steel. Dovetail mounting permits 5½-inch major adjustment of head plus 2½ inches of spindle stroke control. The spindle is advanced and retracted by twin double acting air cylinders. Complete unit includes hydraulic feed control unit, adjustable top dwell, fixture synchronizing stations, adjustable bottom dwell and positive depth control. The electrical control circuit is 110 v and features a compact prewired control unit, with three plug-in jacks for various cycles. Clamping fixture air outlet, pressure regulator, and gage are also provided. **Universal - Automatic Corp.**, 9545 Ainslie St., Schiller Park, Ill.

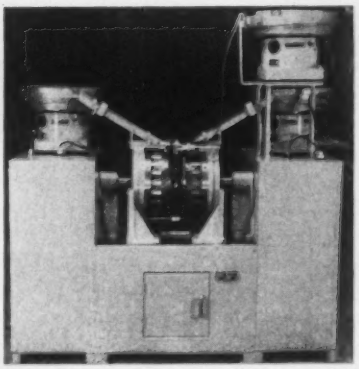
Circle 428 on Page 35



Bar Automatic

Exact spindle speeds and turret tool feeds are set by control knobs and indicated on monitor dials of this 1⅝-inch Model AB single spindle bar automatic. In operation, the appropriate knob is turned—one for each of five turret positions, forward and return—until the speeds and feed rates desired are indicated by dial pointers. There are no change gears or feed cams involved. Spindle speeds range from 40 to 3100 rpm. Ten separate infinitely variable spindle speeds and ten infinitely variable turret tool feeds are available. **Cleveland Automatic Machine Co.**, Cincinnati 12, Ohio.

Circle 429 on Page 35



Resistor Capping Machine

Function of this high-speed machine is to attach terminal cap leads to each end of a resistor body in such a manner that the compressive force between the resistor surface and the cap inner surface effect a good electrical and mechanical contact. The only requirement is to keep caps and bodies supplied to the hoppers. The machine is designed to handle between 9000 and 15,000 pieces per hour depending on parts. It will operate at much higher speeds, if desired. Quick-change dies provide for diameter change from ⅜ to ⅛ inch. Body length and tolerance variation are automatically compensated for in the following range: 2 to ¼ inches. The unit is complete with three plastic-lined vibratory feeders, appropriate chutes, escapement mechanism, one set of dies or body holders, 110 v electric drive motor and all necessary electric controls, safeties and interlocks. **Sigma Engineering Service Inc.**, Box 111, 26 W. Warren Rd., Custer City, Pa.

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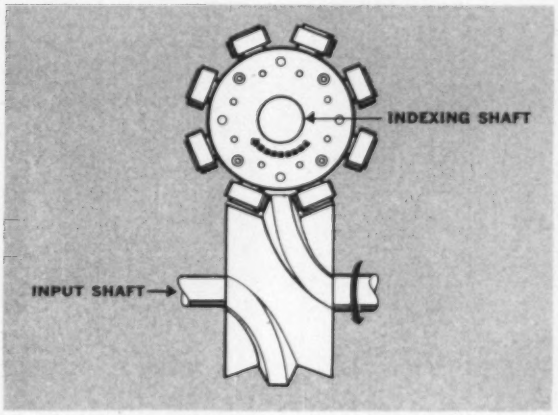
Data Converter

In addition to tape-to-tape conversion this all-solid state data converter can also have card input and card output. It is capable of converting information between punched paper and magnetic tape in either direction at a rate of 3000 words per minute. Basic unit contains the circuitry necessary to accept data from the input, store data, and to feed the data out to the output tapes. Paper tape data may be converted to or from standard 5, 6, 7, or 8-level configurations. Magnetic tape may be in any code format having up to 6 information channels plus one parity channel, with or without a sprocket. The D3000 can be coupled with a magnetic tape handler, a paper tape reader and punch, a card reader, or a card punch unit. **Dykor Div., Digitronics Corp.**, Albertson Ave., Albertson, L. I., N. Y.

Circle 431 on Page 35

How Ferguson *ELIMINATES BACKLASH* in Index Tables

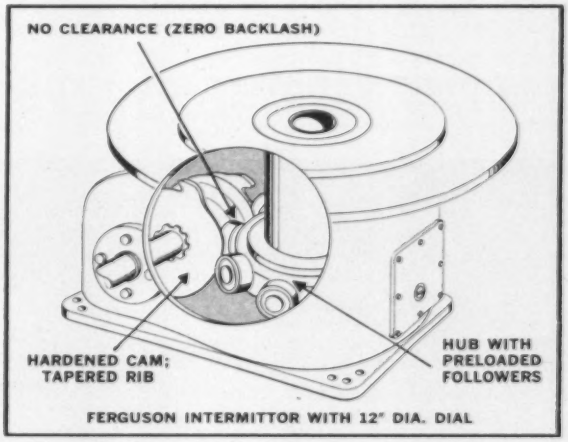
Backlash in indexing results in shock loads that affect the efficiency of a machine and the quality of its product. Most indexing mechanisms have inherent characteristics that cause backlash and poor dynamic conditions and prevent the designer from taking full advantage of modern feeds, tooling and methods that contribute to production economy.



Ferguson Intermittor Index Tables have inherent zero backlash and extreme precision which results in a rotary transfer machine base capable of operating speeds up to 500 indexes a minute. *A Ferguson index table never proves to be a limiting factor in the speed or performance of an automatic assembly machine.*

HERE'S WHY: The continuously rotating cam of a Ferguson indexing mechanism features a *tapered rib* along which two preloaded bearing followers roll, maintaining constant contact with no clearance between them and the rib. When the mechanism is in the rest, or dwell, position, a straight portion of the rib locks the followers with zero backlash and an indexing accuracy of .001". Wear on the hardened tool steel cam is infinitesimal (many have been in use for more than 25 years). Followers are rated for a minimum of 8,000 hours operation. If backlash occurs after this period the life of the drive may be renewed merely by replacing the standard followers.

NOTE HOW PRELOADED FOLLOWERS ENGAGE RIB



FERGUSON INTERMITTOR WITH 12" DIA. DIAL

Compare this with other types of indexing devices. A geneva drive, with its slotted wheel and driver, and a barrel cam with a grooved track which engages one follower at a time, must have clearance in the slot or groove to allow passage of the follower. The slightest amount of clearance causes backlash. As the slot or groove wears, the clearance becomes greater and the backlash condition worsens. At the higher, more profitable operating speeds poor dynamics cause wear on other parts of the machine. The user must choose between frequent downtime for repairs or slower speeds . . . He is the loser in either case.

FREE DESIGN DATA — Load ratings, dimensions and application and installation information about standard and stock Intermittors, Ferguson Drives and in-line machines are contained in a single 36 page catalog. Every designer should have one in his library . . . Write Ferguson—Ask for Catalog No. 160.

FERGUSON
MACHINE CORPORATION
A subsidiary of Universal Match Corporation
7818 Maplewood Court • St. Louis 17, Missouri

Take a close look at this new limit switch! It's so immune to moisture, we'll guarantee it, electrically and mechanically, for one year or 10,000,000 operations . . . whichever comes first. We call it our Super-Sealed SL2-T. If you've ever had limit switch trouble caused by water, soluble oils, condensate or *any* kind of moisture, you'll want complete details. Call, write or wire.

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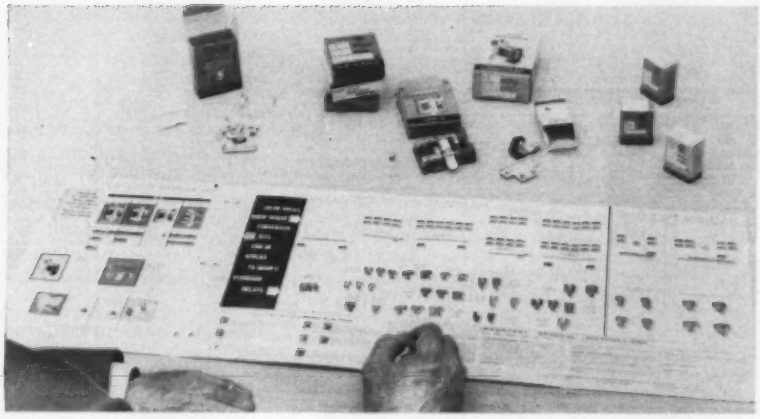
AUTOMATION new components

For detailed information and literature, use card page 35.

Parts, elements and devices designed for creating more automatic systems.

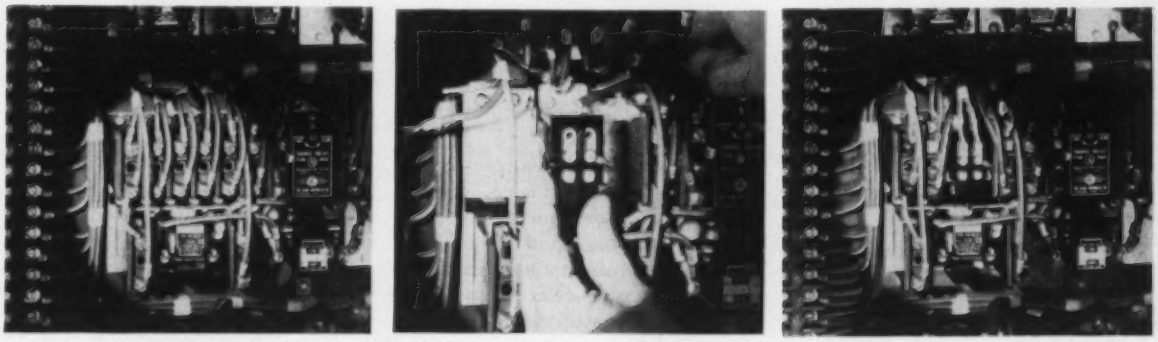


Information chart is printed in black and ten colors which match the color code used on the relay conversion kits. On the left of the chart is a picture and detailed description of each kit. The other three pages of the chart show placement of the kits to build various types of relays. Typical conversion kits are shown above the chart.

Color-Coded Relay Conversion Kits

COLOR-CODED relay conversion kits developed by **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio, are designed to reduce relay inventories by allowing an unlimited number of different relay assemblies to be made from basic parts. The system consists of 30 color-coded conversion kits and an information chart showing how the kits are used to modify standard types of relays in the Clark PM relay line. Each kit is packaged in a cardboard box coded in one of 10 different colors. A total of 24 different pole kits are available along with a latch mechanism kit, a horizontal mechanical interlock kit, and four kits for modifying time delay relays.

The pole kits are furnished in four types with overlap or nonoverlap, normally open or normally closed, standard silver contacts. The pole types are closed-top convertible, open-top single hook convertible, open-top double hook con-



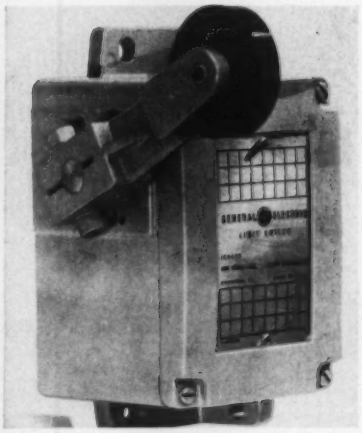
Conversion of a typical relay is shown in this series of pictures. Original relay on the left has eight convertible poles and is to be changed to a latch type relay with one of the poles requiring noble metal contacts to close a high-impedance circuit. After the top row of poles has been removed from the relay mounting plate, the latch mechanism kit is mounted, center picture, above the magnet in accordance with the diagram in the information chart. Modified relay is shown in the right picture. It now contains two universal poles on either side of the latch mechanism and a noble metal pole for the high-impedance circuit. Existing wiring is connected to terminals on the new poles, and two new wires are added to operate the latch-mechanism coil.

vertible, and universal pole. Some of the pole types are also available with antiweld contacts and with noble metal contacts. Each pole kit is color coded to correspond with the background colors used on the information chart. In addition, the pole kits are further identified as to type of contact by means of a symbol in the color block.

The information chart contains detailed data on each kit and three pages of diagrams showing where the various conversion kits may be applied on different relay mounting plates. The chart is printed in black and ten colors to match the colors used on the conversion kits. By referring to the chart, the user can build two to twelve pole relays, latching or nonlatching. Diagrams also illustrate modifications for time delay relays.

A section of the information chart provides data for selecting a magnet coil to match the mechanical load imposed by the addition or deletion of relay parts in modifying a relay. Each pole type has a mechanical load factor. After a relay has been modified, the factors are added together along with a factor for a latch mechanism (if used) and an accumulation factor if 9 or more normally closed convertible poles are used. This results in a total mechanical load factor. By referring to a Coil Application Table in the chart, the proper magnet coil for 110 to 600 volts and 25, 50, or 60 cycle operation may be selected. Also included is a table for determining volt-ampere requirements for various mechanical load ranges.

Circle 432 on Page 35



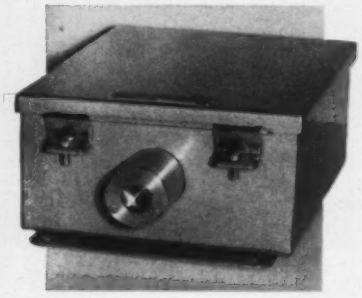
Limit Switch

Heavy-duty lever limit switch has been designed for mill and general industrial applications and to give improved service on cranes, hoists, industrial conveyors, and elevators. It can be used as a pilot circuit device to limit travel or setup functions at predetermined positions and may be adjusted to provide more than a hundred different contact and lever combinations. Model IC9445 limit switch is available for either two or four-circuit operation. It can be either base or side-wall mounted. A selection of lever arms which may be used interchangeably is available. **General Electric Co.**, Schenectady 5, N. Y.

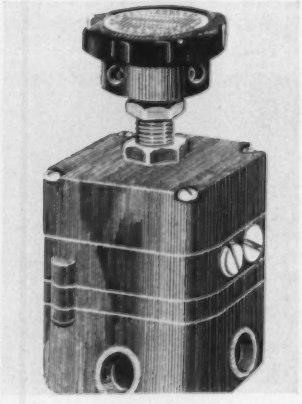
Circle 434 on Page 35

Infrared Detector/Relay

Infrared detector/relay senses the presence of a moving hot object having a temperature of 600 to 2000° F and operates a relay to start, stop, or adjust relay-controlled equipment associated with a process. It does not sense a stationary background, such as a furnace door or an overheated runout table in a mill, but only the higher temperature material moving through. The unit is suitable for use under adverse operating conditions such as high ambient light levels, dust and steam atmospheres, and wide temperature fluctuations and input overloads. It is drift-free and can be used at distances up to 20 feet from the material. Uses include the following applications; To close the exit door of a furnace as material clears the door; to start and stop water sprays, coilers, conveyors; to signal the occurrence of cobbles or abnormal movement of material; to reverse rolls and switches; and to count and record the number and frequency of operations of blooms, billets, bars, or coils. The detector/relay is available in three models: Model 901, standard unit with integral sensing unit; Model 902 with remote location sensing unit; and Model 903 with water-cooled remote location sensing unit for use in ambient temperatures above 125 F. Power requirements of the device are 100-125 v, 60 cycles, 1 ampere; and normal, ambient temperature range is from 0-125 F. Output is through a normally open or normally closed single pole relay rated at 2 amperes, 115 vac or 28 vdc, noninductive. Response time of the unit is 20 milliseconds, and cone of vision is 3 degrees. Minimum width, or diameter of the detected object, in inches, divided by the source-detector distance, in feet, should be equal to 0.05 or greater. The minimum spacing between successive objects should be equal to 2 times the field size. Auxiliary components include a light shield for use with either the standard or remote location sensing units to avoid the possibility of accidental actuation due to nearby moving hot objects, a mounting bracket, and a load isolating relay. **Electron-Machine Corp.**, Umatilla, Fla.



Circle 433 on Page 35

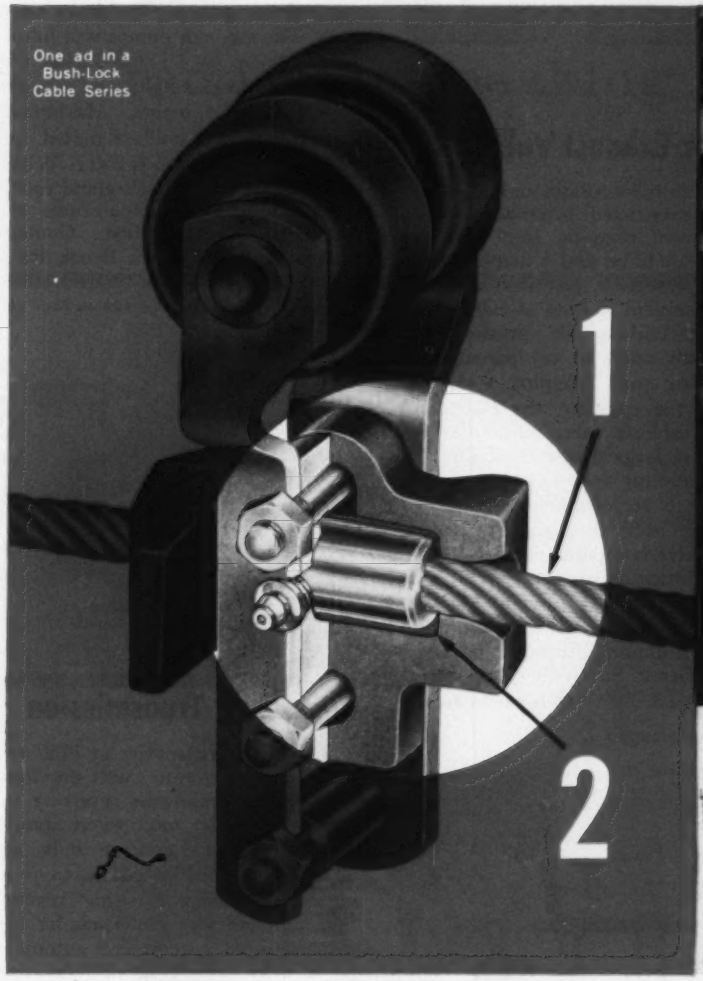


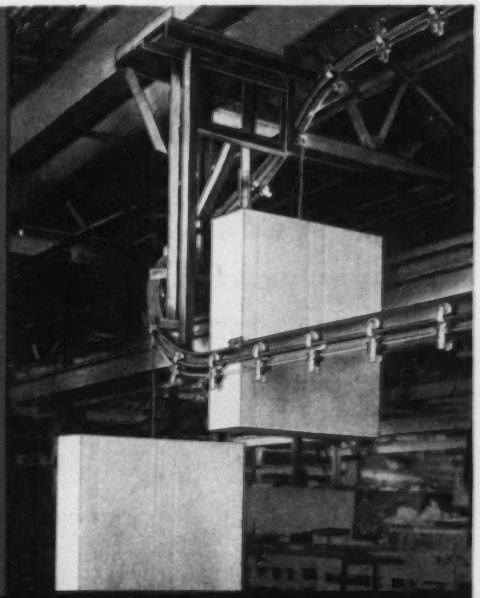
Air Pressure Regulator

Developed for precise control of air or gas pressure, this high accuracy regulator holds pressure to 1/50 of 1 per cent of its range over substantial variations in supply pres-

2 BASIC PATENT FEATURES

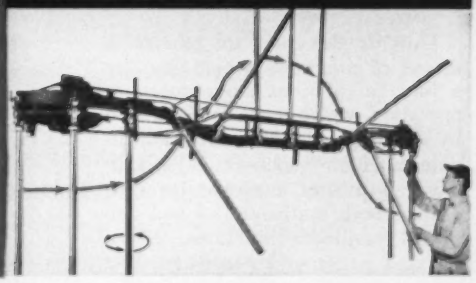
. . . . . with unlimited applications





Bush-Lock permits spiraled end turn for large parts clearance on close centered parallel tracks.

Bush-Lock's floating action permits trolleys to follow a special path while the cable travels in a straight line. No other conveyor can do this.



The low-cost efficiency that industry finds in long-lived Bush-Lock cable conveyors is obtainable in no other overhead system. For only Buschman patents cover these essentials: 1) straight-through continuous power cable—100-ft. lengths without a joint or link; 2) radially-free trolley alignment with track.

1. STRONG *PULLING* ELEMENT is the straight-through continuous cable . . . in 100-ft. lengths, with half buttons for quick coupling. Cylindrical buttons are swaged on cable, float free within trolley cavities, relieve any spiral twist and ensure true alignment with track. Only in Bush-Lock can the cable pull straight, even when path of trolleys and load is diverted. No restraining screws and clamps, no built-in strains, no links and wear points.

2. ROTARY *FLOATING* TROLLEY ACTION . . . Mating half section blocks bolt easily around swaged buttons to form cylindrical *cavity* in which the button rides free. This prevents cable strain of the clamped design. Trolleys align themselves without restraint. *The cable has factory built-in lubrication.* Bush-Lock cavity is pressure lubricated.

Bush-Lock features can be engineered to your needs, as they are in thousands of other plants. Get further details and see how they can serve *you*. Write for Engineering Data No. 52A, to The E. W. Buschman Company, 4551 Clifton Ave., Cincinnati 32, Ohio.

• • •

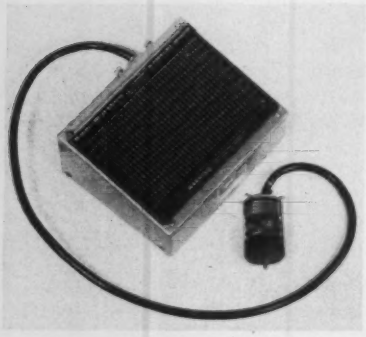
Buschman
CONVEYORS

Complete Conveyor Systems for all Types of Industries:
Engineered, Manufactured, Installed.
Representatives in Principal Cities; See Yellow Pages.

Circle 697 on Page 35

sure, flow, and ambient temperature. Its resolution is one part in 10,000 of range. Unit uses the lower regulated pressure for pilot energy, feeding it through a high-gain servo system in which the main valve action is controlled by a pilot nozzle. The result is low air consumption, precise control, and instantaneous response, even when there are wide variations in supply pressure. The regulator is available in 2-25, 3-60, or 3-120 psi ranges for ⅛, ¼, or ⅜ NPT pipe. **Lexington Controls Inc.**, P. O. Box 132-J, Burlington, Mass.

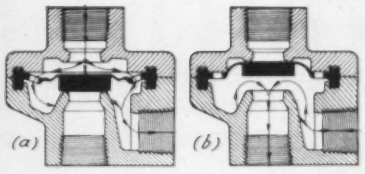
Circle 435 on Page 35



Function Generator

Unit is designed to provide a means of programing operations as a function of time. Any process or operation which can be controlled by a voltage can utilize this adjustable function generator. The generator furnishes a means for generating both mathematical and empirical nonlinear functions. It can be used either as an instrument or as a component, as a laboratory design tool or in a fixed instrument or computer installation. The function adjusting assembly is available in two versions, Models 12B4 and 12B6 nominally rated for 60 or 400 cps operation respectively. Both units utilize 34 voltage adjusting sliders with a resolution of voltage adjustment of ±0.05 per cent. They operate over a wide carrier frequency range, 20 to 5000 cps. Available in three sizes, the interpolating generators have a maximum output impedance from 40 to 470 ohms. **Vernistat Div., Perkin-Elmer Corp.**, Emerald St., Norwalk, Conn.

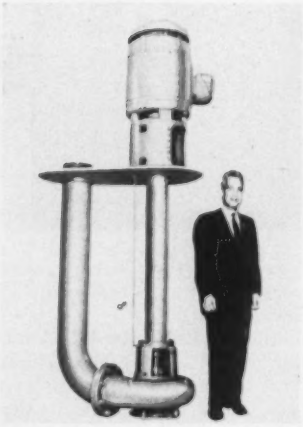
Circle 436 on Page 35



Quick Exhaust Valve

Device incorporates smooth, oversize, unrestricted internal passages to prevent clogging from contaminated air lines, and a diaphragm of special design to give instantaneous and complete venting of exhaust air from cylinders, air presses, and other air operated equipment. By providing quick dumping of exhaust air at the cylinder, the Pneu-Trol quick exhaust valve eliminates the need for large diameter piping and large selector valves, ordinarily required to accommodate exhaust air moving back through the system. The valve is capable of operating in any position and is made for ⅜-inch pipe sizes. Recommended operating pressures are 125 psi maximum and 5 psi minimum. **Auto-Ponents Inc.**, 3001 Grant St., Bellwood, Ill.

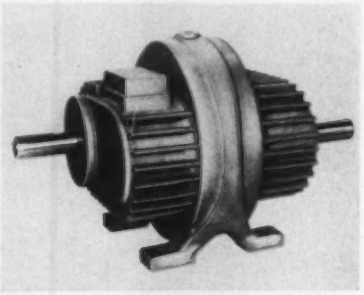
Circle 437 on Page 35



Centrifugal Pumps

Six and eight-inch discharge units have been added to a line of heavy duty vertical centrifugal sump and process pumps. They increase the capacity range of the line from approximately 1000 to over 3000 gpm. They are available for pit depths of from 3 to 20 ft for either dry pit or wet pit service, and can be furnished in iron, bronze fitted, or stainless steel construction. The open impeller used on all units has ejecter vanes on the back side which effectively prevent entrance and jamming of solid materials between the back of the impeller and the stationary side plate. The six-inch pumps will handle solids up to 1 11/32 inches in diameter, and the eight-inch pumps up to 2 27/32 inches. Maximum temperature of liquids handled in standard construction is 200 F. With stuffing box and quench gland cooling, liquids with temperatures to 350 F can be handled. **Goulds Pumps Inc.**, 205 Black Brook Rd., Seneca Falls, N. Y.

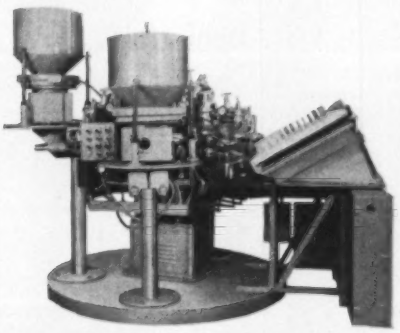
Circle 438 on Page 35

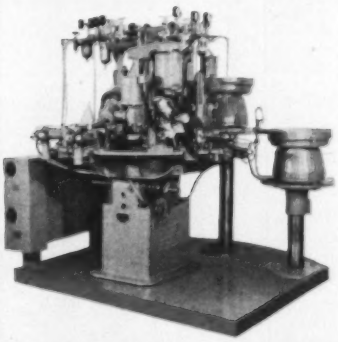


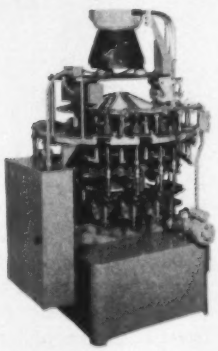
Reversing Transmission

Rated five-horsepower at 1750 revolutions per minute, unit provides virtually instantaneous reversing in 0.2 second under most severe conditions. Designated as Electromission, it was developed primarily to provide high-speed positioning, reversing, and sequencing of loads for industrial servo systems and automated systems using card or tape control. Low power requirements of the transmission permit simple remote control systems drawing control power from a conventional 110-v supply. The unit is capable of transmitting torques in excess of 250 pound-inches under transient conditions, while its capability under steady-state conditions at any desired speed is 180 pound-inches. Transmission consists of an input and output shaft, connected through either a gear drive or a chain drive —depending upon the status of two opposing electromagnetic clutches. Engaging one clutch provides chain drive—for same-direction rotation of the output shaft compared to input

Practically Speaking . . .







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We don't. BUT—

We had twenty years of specialized experience in designing and building automatic processing and assembling machines *before* the word was ever coined.

In designing and developing good automatic machines, there is no substitute for experience and you can have the benefit of ours without extra cost or obligation.

Whether it's for complete machines or one of our 200 tested and proven Standard Indexing Machine Chassis ready for application to your own designs, you owe it to your company to investigate.

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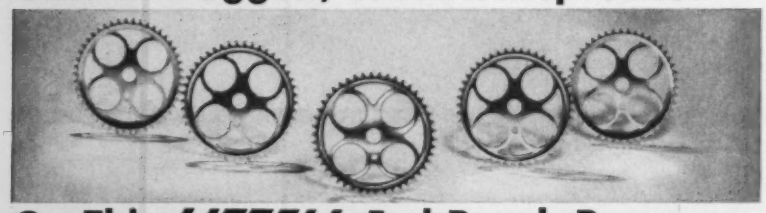
AUTOMATIC ASSEMBLING AND PROCESSING MACHINES

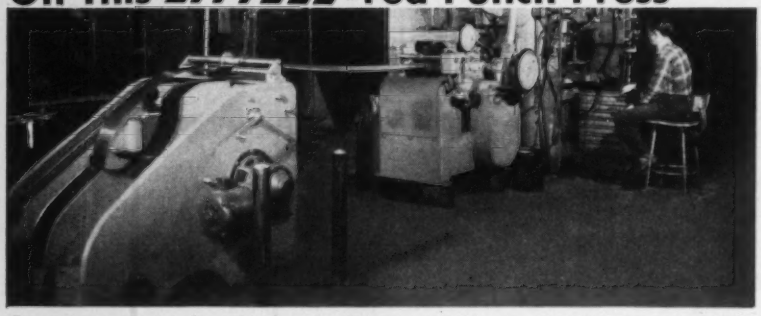
Circle 698 on Page 35

The Schwinn Bicycle

Gets Its Rugged, Precision Sprocket

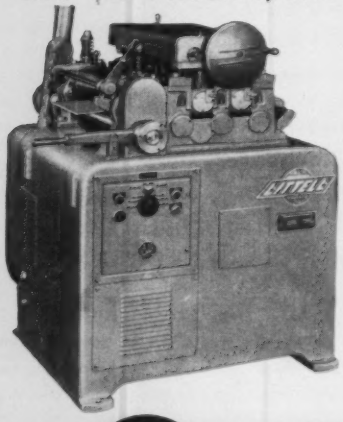


On This *LITTELL*-Fed Punch Press



Stamping out sprockets for famous Schwinn Bicyles is *precision* stamping. The special high strength steel stock is perfectly conditioned for accurate work. Flat stock, free of coil curvature, reaches the die area at perfectly timed intervals. For sprockets and other vital parts, Schwinn achieves this straightening-feeding precision economically, using the Littell "HRP" self-powered, hydraulically driven feeding and straightening machine. The "HRP" will serve you as well.

"HRP" is Versatile, Accurate, Convenient



The straightening-feeding cycle of the self-powered HRP unit is synchronized with the stamping cycle of the press by a single electrical connection. HRP units remove the coil curvature, and feed the straightened stock to the press or shear at precisely the desired speed. They feed from either side of the press, or from front to back. They can be positioned at special angles to produce specially shaped parts. Pulling an electrical plug disconnects the "HRP" from the press. Furthermore, the "HRP" can be easily moved from press to press by a lift truck. Facts in Bulletin B-10.

3 STANDARD "HRP" SIZES

STOCK CAPACITIES

12" wide x .090" thick
18" wide x .062" thick
24" wide x .050" thick

F. J. LITTELL MACHINE CO.

COILY Says:
"Get Bulletin B-10.
All facts. No charge."
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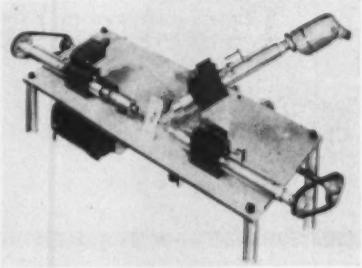
shaft. Engaging the other clutch produces gear drive—for opposite-direction rotation of the output shaft. **Industrial Div., Airborne Accessories Corp.**, 1414 Chestnut Ave., Hillside 5, N. J.

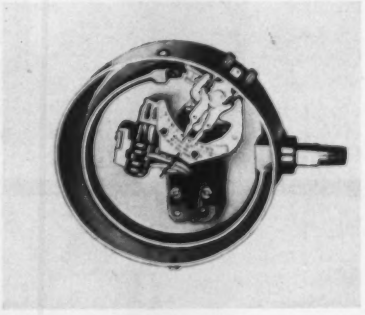
Circle 439 on Page 35



Drill Unit

Multiangle drill unit with a drill capacity of ¼ inch provides unlimited mounting flexibility to handle angle or off-line drilling jobs. The unit incorporates a two-way air cylinder which provides both feed and return of the spindle. Any length stroke may be set up to the unit's full capacity. Type A unit's small size and long stroke make it ideally suited for a wide variety of production drilling set-ups. It is designed to permit quick attachment to a flexible shaft or an electric motor power source. **Commander Manufacturing Co.**, 4225 W. Kinzie St., Chicago, Ill.

Circle 440 on Page 35



Pressure Controls

Series of pressure controls offers a wide range of applications in many fields. All parts of the controls in direct contact with the pressure mediums are made of 316 stainless steel. Operating ranges are 30

WEATHER

Fair, Mild

T-J

TOMKINS-JOHNSON TRIBUNE

★★★★★

FINAL

THE TOMKINS-JOHNSON CO. • 2425 W. Michigan Ave. • Jackson, Michigan

INCREASED PRODUCTION... CREATES PRICE ADJUSTMENT

on T-J Squair Head Cylinders

JACKSON, MICH. JAN. 3 (TP)—"Due to the tremendous initial response and the continuing acceptance and purchase of the new Tomkins-Johnson Squair Head Cylinders, it has been possible to *lower* the basic price," according to T-J personnel. In effecting this price cut, Tomkins-Johnson has again proven that acceptance of a quality product and the inevitable increase in manufacturing volume *CAN* economically justify a price reduction *WITHOUT* jeopardizing quality.

The T-J Squair Head Cylinder, an interchangeable air cylinder for any pneumatic power application, was first introduced by Tomkins-Johnson in 1958. It was an immediate success because of its availability in a wide range of bore sizes and strokes . . . as well as the standard quality features, including the new T-J Super-Cushion for air cylinders.

Other Standard Features

Other standard T-J features that allow the T-J Squair Head Cylinder to retain its high quality comparison over other makes of air cylinders and still give you lower price are; solid steel heads and mounting plates, hard-chrome plated bodies and piston rods, leak-proof cylinder head to body construction, heavy duty, high tensile ground and polished chrome, plated piston rod, and many more . . . STANDARD AT NO EXTRA COST.

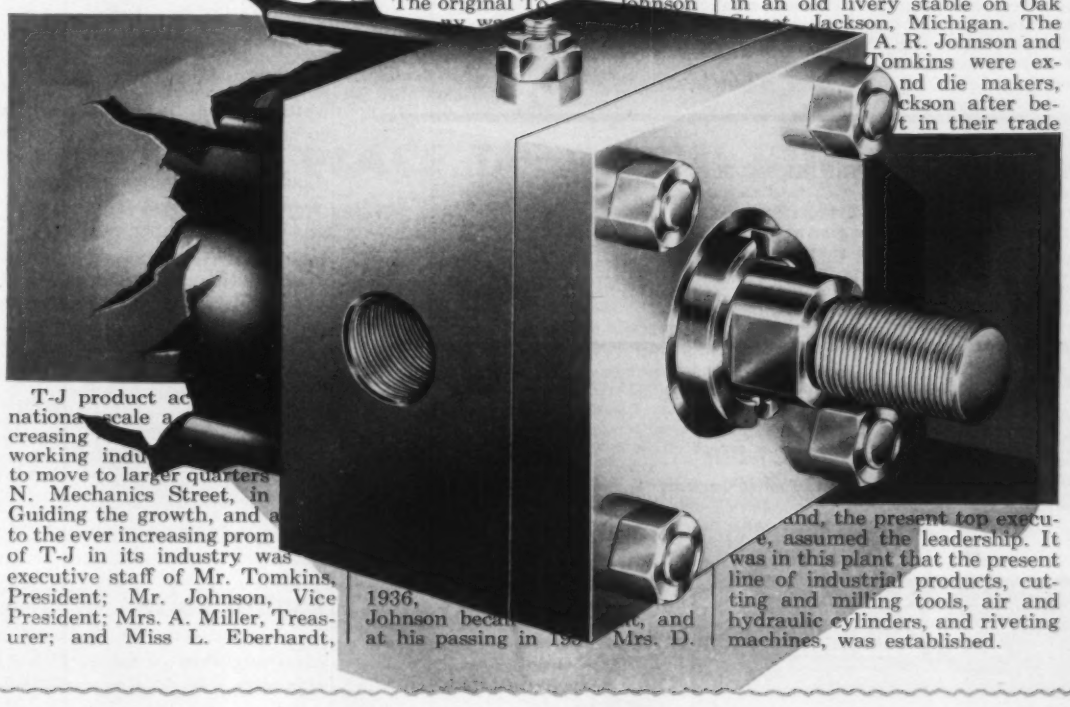
Tomkins-Johnson, by virtue of the announced lower cost on its Squair Head Cylinder, wish to thank their customers for their initial acceptance which has been such a contributing factor in this price reduction.

T-J Produces Complete Line

Tomkins-Johnson also produces a complete line of hydraulic and pneumatic cylinders for *EVERY* power drive application . . . including the very popular Spacemaker. If you need further information or complete catalog material, write T-J direct, or request it from your T-J sales representative.

The Tomkins-Johnson Company was founded in 1917

The original To Johnson ay w in an old livery stable on Oak t, Jackson, Michigan. The A. R. Johnson and Tomkins were ex- nd die makers, ckson after be- t in their trade



T-J product ac nationa scale a creasing working indu to move to larger quarters N. Mechanics Street, in Guiding the growth, and a to the ever increasing prom of T-J in its industry was executive staff of Mr. Tomkins, President; Mr. Johnson, Vice President; Mrs. A. Miller, Treasurer; and Miss L. Eberhardt,

1936, Johnson beca t, and at his passing in 19 Mrs. D.

nd, the present top execu- e, assumed the leadership. It was in this plant that the present line of industrial products, cutting and milling tools, air and hydraulic cylinders, and riveting machines, was established.

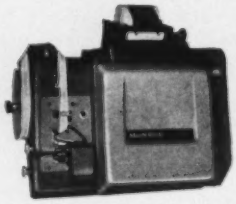
Circle 700 on Page 35

MONROE

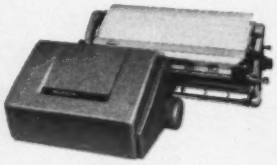
DATA RECORDING WITH MONROE DATA/LOG PRINTERS

MONROE DATA/LOG PRINTER MC-215
Serial entry • Programmable or narrow fixed carriages • One or two accumulators, or print only • 18 digits per second • 142 print cycles per minute • Black and red print • 11 digits per print cycle • 12 digit totals • Motor driven carriage, 82 digits per line • Vertical space on command • Symbol type bars • Pin feed platens • Automatic Line Finder carriage

MONROE DATA/LOG PRINTER MC-205
Parallel input • 5, 6, 7 or 8 channel tape output, any code • 13 or 4¾ inch fixed carriage • One or two accumulators or print punch only • Print and punch 64 cycles per minute • 10 digit maximum plus functional codes punched automatically • IBM card punch output optional • Cabled manual electrical keyboard



MONROE DATA/LOG PRINTER MC-203
Parallel input • Programmable carriage • 3 to 14 digits per print cycle • Up to 4 accumulators with 14 digits each, or print only • Vertical space on command • Carriage return on command • Red print, black print • 2½ print cycles per second • Cabled manual electrical keyboard • Pin feed platens • Symbol type bars



MONROE DATA/LOG PRINTER MC-202
Parallel input • 13 or 4¾ inch fixed carriage • Front feed carriage or around platen carriage • One or two accumulators or print only • Symbol type bars • Cabled manual electrical keyboard • 10 digit maximum • One or two accumulators • 11 digit total • Pin feed platens

DATA/LOG PRINTER WARRANTY. Each Monroe DATA/LOG printer carries a first year's warranty and maintenance guaranty. Following the first year, each unit can be placed on yearly maintenance contract by any of the more than 350 established Monroe service offices in the United States, or by Monroe offices abroad.

Technical specifications and wiring diagrams are available on request.

MONROE DATA/LOG PRINTERS

Call your local Monroe Office or write to:
MONROE Calculating Machine Company, Inc.
Electronics Components Division
60 Main Street,
San Francisco, Calif.

inches vac to 75 psig; 10 to 100 psig, 30 to 400 psig, 75 to 800 psig and 100 to 1000 psig. Differentials are available for general pressure applications, for applications requiring close differentials, or where sensitive differentials are needed. These controls are available in General Purpose case NEMA 1; Weather-Proof NEMA 2, 3, 4; Explosion - Proof NEMA 7, 9, 9A, (Class I, Group C & D; Class II, Group E, F, & G). **Mercoid Corp.**, 4201 Belmont Ave., Chicago 41, Ill.

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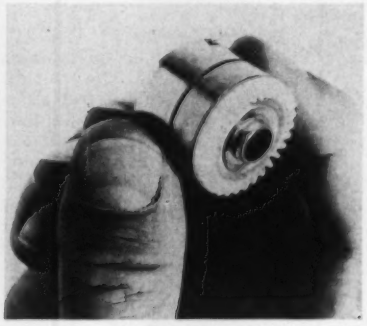

Magnetic Clutch

Used to drive potentiometers, servo balance units, remote controls, and speed changers, this miniature magnetic clutch has a minimum torque rating of 10 oz-in. at speeds to 1000 rpm. It is available in four voltage ranges including 6, 12, 28, and 90. All ranges operate at 2.5 watts. Model 162 occupies about 1 cu in. of space. It will operate to 85C and withstand severe humidity, shock, and air pressure conditions. A 120 per cent overvoltage is permissible for a 50 per cent duty cycle. **Ultronix Inc.**, 111 E. 20th Ave., San Mateo, Calif.

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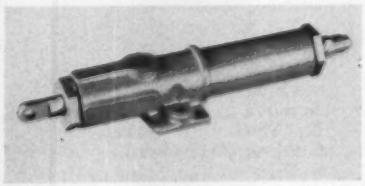
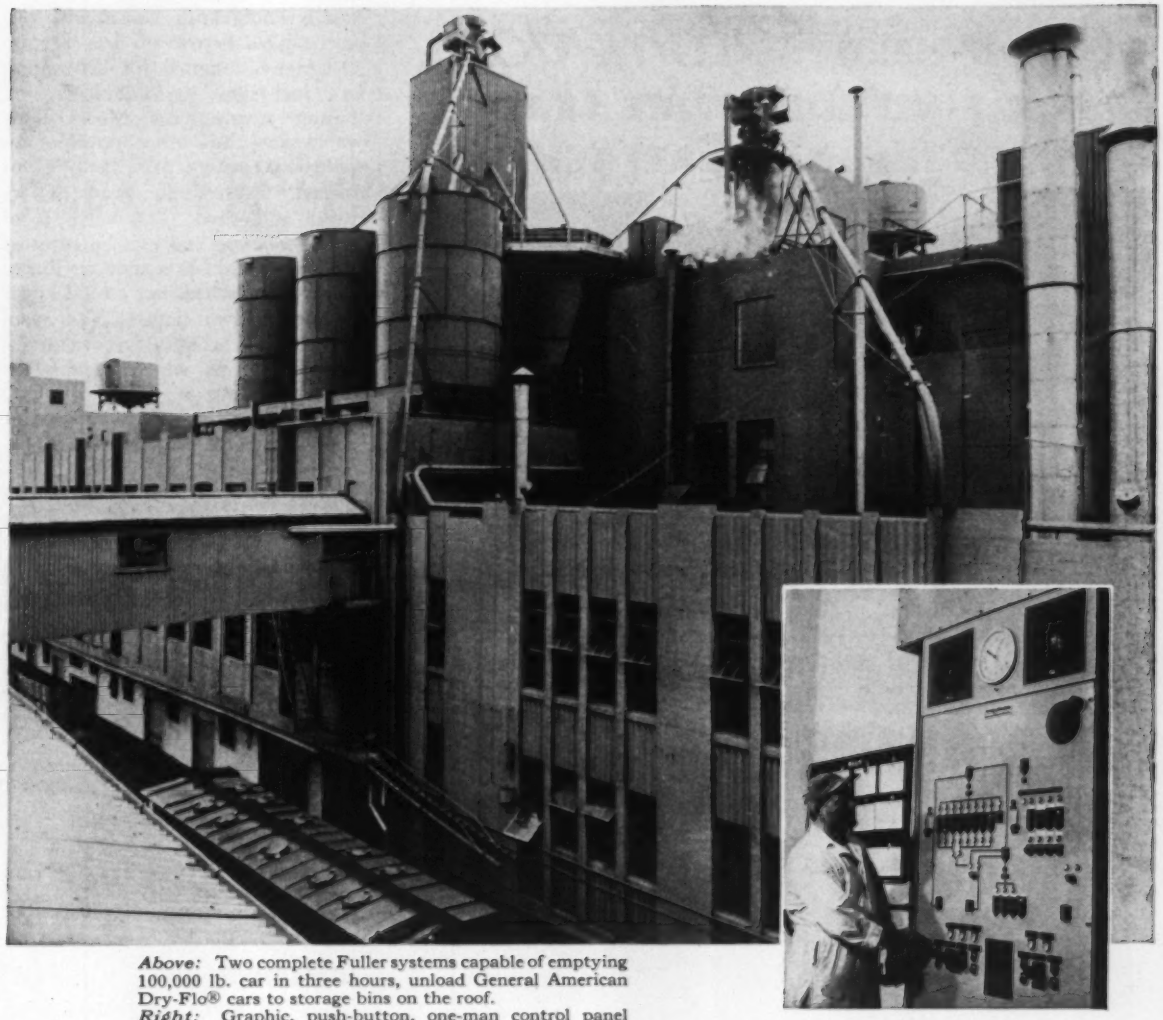


Control Valve

Control valve for automatically governing flow of noncorrosive liquids with straight-line variations in

Circle 701 on Page 35



Above: Two complete Fuller systems capable of emptying 100,000 lb. car in three hours, unload General American Dry-Flo® cars to storage bins on the roof.
Right: Graphic, push-button, one-man control panel handles unloading, conveying and reclaiming.

NO PLACE TO GROW BUT UP

. . . so Burgermeister put 12 new storage bins on the Brewhouse roof

Putting a head on beer is one thing, but putting a head on the Brewhouse roof might seem an insurmountable obstacle. This growing San Francisco brewery was up against it for storage space. With no further room for lateral expansion, the only place to grow was up—but how? Could additional bins be loaded at such a height?

Fuller engineers were able to provide the answer. Airveyor® Pneumatic Conveying Systems don't balk at height. So twelve additional bins were mounted on top of existing equipment, and two separate Airveyor systems were installed. They even incorporate components from an existing Airveyor system which had been installed in 1947.

Now, with ample storage space, grits are unloaded from covered hopper cars to bins in just over three hours per 100,000-lb. car. The same quantity of malt travels the route in a little over two hours. And reclaiming and blending are handled at an equally high rate—all controlled by one man at a Fuller graphic control panel. Burgermeister has greater production with greater economy — as breweries must do to keep ahead today.

The success of Fuller in handling problems like those at Burgermeister is confirmed by repeat orders from customers everywhere. Breweries nation-wide look to Fuller to study their needs for expansion, higher production and for new brewery installations. Why not find out for yourself why they do it—and what Fuller can do for you? 2625 A-29 2

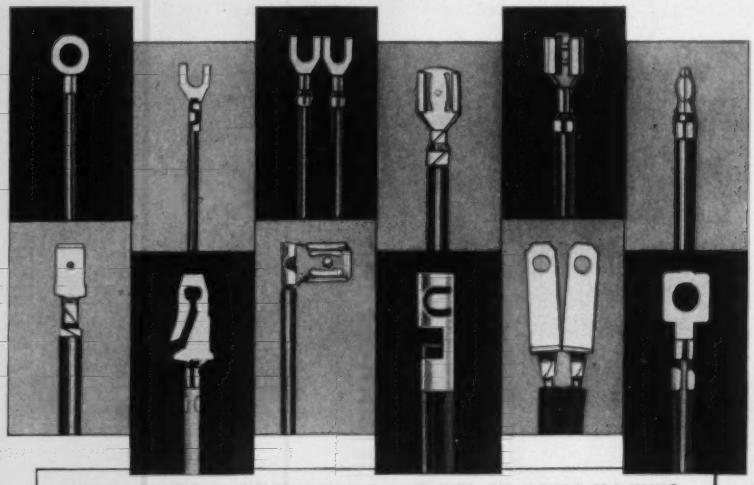
"See Chemical Engineering Catalog for details and specifications".

FULLER COMPANY GENERAL AMERICA TRADE MARK

FULLER COMPANY
162 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
....pioneers in harnessing AIR

DO YOU NEED *Automation* FOR FINISHING WIRE LEADS WITH TERMINALS ATTACHED?



SOME EXAMPLES OF TERMINALS ATTACHED BY ARTOS MACHINE

NEW ARTOS TA-20-S Performs 4 Operations *Automatically!*

Artos TA-20-S with guard raised

1. Measures and cuts solid or stranded wire 2" to 250" in length.
2. Strips one or both ends of wire from 1/8" to 1".
3. Attaches any prefabricated terminal in strip form to one end of wire. (Artos Model CS-9-AT attaches terminals to BOTH ENDS OF WIRE simultaneously.)
4. Marks finished wire leads with code numbers and letters. (Available as optional attachment.)

PRODUCTION SPEEDS up to 3,000 finished pieces per hour. Can be operated by unskilled labor. Easily set up and adjusted to different lengths of wire and stripping—die units for different types of terminals simply and quickly changed.

ENGINEERING CONSULTATION . . . recommendations without obligation. Special adaptations made to fit requirements of your product. Machines for all types of wire lead finishing.

AGENTS THROUGHOUT THE WORLD

WRITE for FREE Bulletin No. 655 on Artos TA-20-S

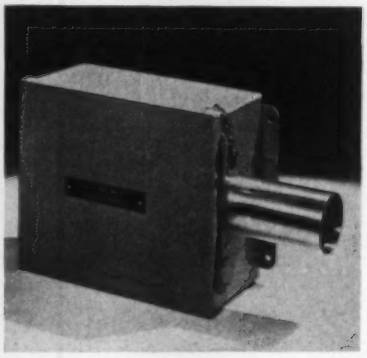
World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin

rate is available in 3 sizes, with ratings ranged between 5 and 60 gph. Originally designed for controlling the fuel flow to variable-fire oil burner nozzles, the Mod-U-Flow valve now has other possible applications where an easily controlled, low-volume modulating valve is desired. The valve is of the spool type and can be adjusted by any straight-line actuator linked to the stem, which has a total linear motion of two inches. The spool cylinder has a spiral groove of increasing depth which meters the flow depending on what point along this graduated groove is exposed at the intake. **Hill Machine Co.**, Rockford, Ill.

Circle 443 on Page 35



Infrared Relay

Ultrasensitive directional infrared ray operated relay has been designed for detecting temperature changes. Designated as Model 5121, the device can be employed at a distance from hot forming processes to actuate water sprays, take-up reels, pouring devices, furnace doors, conveyors, counters, and other auxiliary equipment. The optical system and detector element provide a field of vision approximately 12 inches square at a distance of 20 feet from the relay, 6 inches square at 10 feet, etc. Set for maximum sensitivity, the relay is energized at 10 feet distance by an object as small as 1 inch square, at a temperature of 1100 F, and moving at a speed of about 6 inches per second. As long as the hot object remains in the optical field of vision, the relay will remain energized. It requires no water cooling. Normally open and normally closed relay contacts are provided. Unit

YOU CAN BE SURE OF UNIFORM PERFORMANCE FROM O-M CYLINDERS

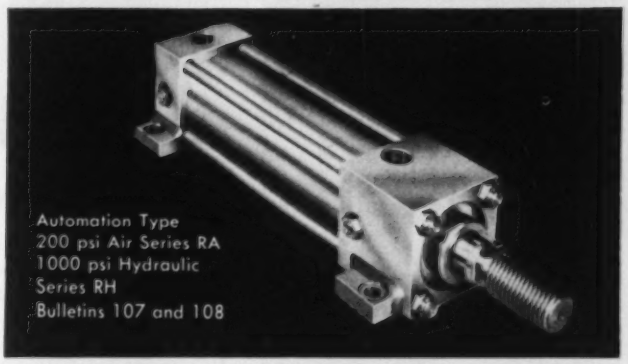
Whether you operate O-M Cylinders, of the same psi rating, bore and stroke, singly or in sequence, each one will exert the same force, handle the same work load, with the same precision. In addition, the direction of each stroke, length of each stroke as well as the time interval between cycles will be controlled to the same high degree of accuracy. As all parts and mounts of O-M Cylinders, of the same capacity, are micro-honed or accurately machined to the same close tolerances, they are interchangeable and precise. Uniform operation is automatic.

O-M Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Complete line of interchangeable parts and mounts. Immediate delivery on most sizes.

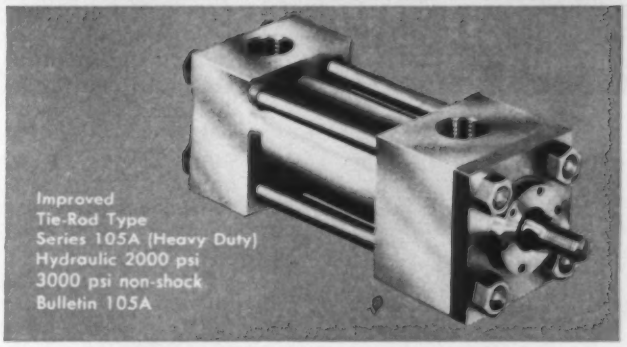
Coupon below will bring our latest bulletins showing construction and dimensional details, engineering drawings, capacity chart and mounting data for each O-M Air and Hydraulic Cylinder.

Mail Coupon Today for Your Copies

Internal Key
Tie-Rodless Type
Series 101A
Air—150 psi—up to
1500 Hydraulic
Fits where others won't
Bulletin 101A



Automation Type
200 psi Air Series RA
1000 psi Hydraulic
Series RH
Bulletins 107 and 108



Improved
Tie-Rod Type
Series 105A (Heavy Duty)
Hydraulic 2000 psi
3000 psi non-shock
Bulletin 105A

ORTMAN-MILLER MACHINE COMPANY
25 143rd Street, Hammond, Indiana

☐ Have representative call

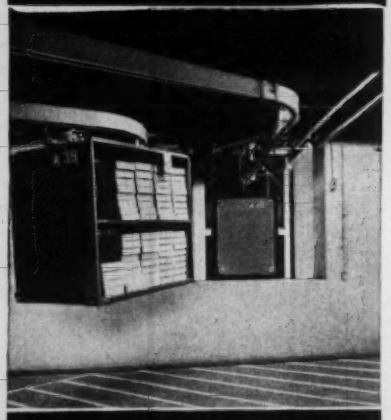
Send Bulletins
☐ 101A ☐ 105A ☐ 107 ☐ 108

NAME_____ POSITION_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____

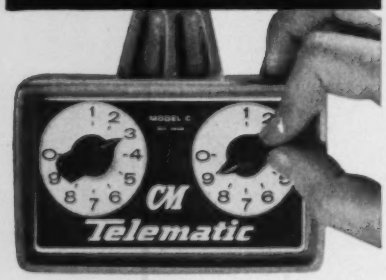
Circle 704 on Page 35

Power -Flex®

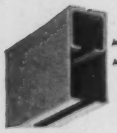
POWER AND FREE OVERHEAD CONVEYOR SYSTEM*



WITH **TELEMATIC** AUTOMATIC DISPATCH CONTROL



• *Simply set dials and Telematic guides carrier to any station in system*



Employs exclusive unitized "over and under" power and free rail which permits simple switching to right or left as desired.

Power-Flex is designed for automated materials forwarding applications in industrial plants, distribution centers, service buildings and department stores. The most economical system available for loads up to 600 lbs. per carrier. Savings in actual installations range from 25% to 60%.

*Systems in service for your inspection.

Engineered to your very specific requirements.

SEND FOR BROCHURE

Inquiries from your engineers or consultants welcomed.

CM CONVEYORS

COLUMBUS McKINNON CORPORATION

Conveyor Division

TONAWANDA, N. Y.

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operating requirements call for 115 v ±10 per cent, 60 cycle, 1 amp. **Weston Instruments Div., Daystrom Inc.**, 614 Frelinghuysen Ave., Newark 12, N. J.

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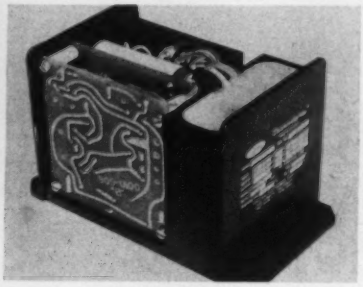

Solid State Converter

Series 763 transistorized converters, utilizing printed circuitry, are designed to replace motor generator and vibrator type devices for the conversion of dc input voltages to dc outputs of different voltage levels. Designated as Transidyne, these converters are available in 15 standard models varying in output voltage from 10 to 150 v dc with a nominal 28 v dc input. Protected screwdriver adjustment allows ±5 per cent output voltage adjustment. Maximum output power is 75 watts; maximum output current 4.0 amps; maximum ripple 20 mv rms; and regulation 0.1 per cent. Operating temperatures range from −55 to +71C. **Spectrol Electronics Corp.**, 1704 S. Del Mar Ave., San Gabriel, Calif.

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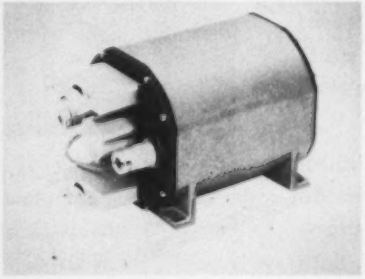

Sampling Switch

Magnetically actuated sampling switch is capable of fast operation at extremely low signal levels. It has a life expectancy exceeding 200 million operations and is suited to the rapid sampling of multiple low level transducers such as strain gages and thermocouples. In many applications the switching unit introduces less than 10 microvolts of extraneous signal into the circuit being commutated regardless of impedance level. A single switching unit may be used to commutate as many as 90 double ended channels at rates up to 3000 total samples per second. A magnetic force acting to hold the moving contact in either open or closed position exceeds 200 g. Switch has a temperature range from 30 to 165 F. Addition of a thermostatically controlled heater element makes the switch operable from −60 to 165 F. **Magnavox Research Laboratories**, 2928 Maricopa Ave., Torrence, Calif.

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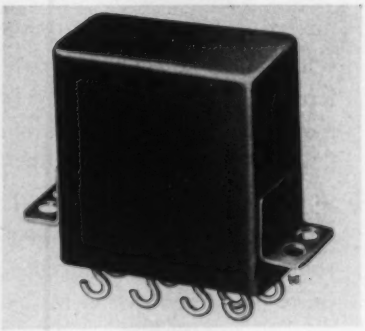
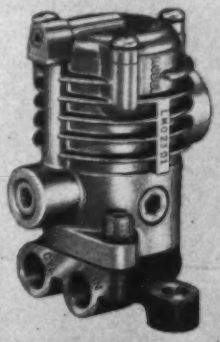
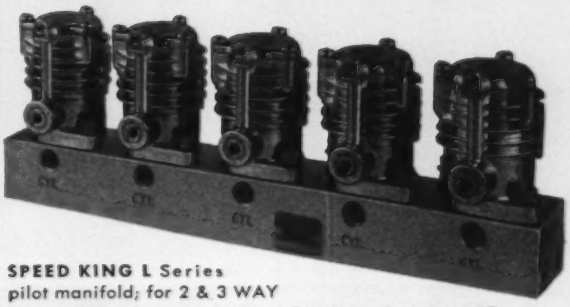


Latching Relays

Polarized magnetic latching relays have been developed for use in electronic logic circuits, computer storage elements, and automated machines. Both single (Type JP) and two-coil (Type JPA or JPB) models are available. Five mounting variations are supplied with eight 0.2-inch grid-spaced terminals (JP) and with 1 (JPA) or 2 (JPB) additional coil terminals for the 2-coil type. Hook type solder terminals or straight pins for printed circuit applications are available for any standard grid sockets. Designed to resist 100g shock, the relays can withstand vibration of 30g up to 2000 cycles. Contact ratings are 2 amps at 29 v dc, and 1 amp at 115 v ac; low level contacts are also available. Operating conditions are as follows: Ambient temperatures, −65C to 125C; contact resistance, 0.05 ohms; dielectric strength, 1000



SPEED KING L Series pilot; 2 & 3-way NO & NC; foot, subbase or manifold mounting; 1/16 to 1/8 in. orifices. Subbase mounting shown.

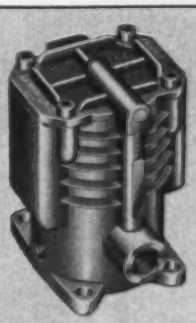


SPEED KING L Series pilot manifold; for 2 & 3 WAY NO or NC pilots; 2, 3, 4 or 5-station, 1/4 in. NPT cylinder ports. 5-station shown.

for dependable, economical control, specify versatile...

SPEED KING®

SOLENOID PILOTS



SPEED KING P Series pilot; 2 & 3-way NO & NC, 4-way; foot, subbase or manifold mounting; 1/8 or 3/16 in. orifices. Foot mounting shown.

Compact Valvair® SPEED KING pilots are ideal for control of small air or vacuum-operated devices including cylinders up to 3 in. bore, as well as for piloting larger valves. Featuring Valvair's flow-thru cooling design, they offer multi-million cycle dependability, with solenoid coils guaranteed against burnout for the life of the valve. Choose from a full range of types, mounting styles and sizes; integral junction boxes (L Series only) and manual override optional; coils for ac or dc, any voltage.

Solve your small unit control problems with SPEED KING solenoid pilots. Your Bellows-Valvair Field Engineer can recommend a size and type exactly suited to your requirements.

Write for free Bulletin PIL. Address: Bellows-Valvair, Akron 9, Ohio. Dept. AU-261.

8162

NFPA NATIONAL FLUID POWER ASSOCIATION

Bellows-Valvair

AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

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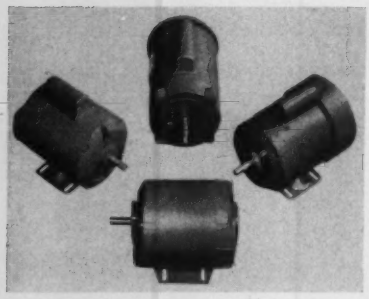
v rms at sea level; and insulation resistance, 10,000 megohms. **Allied Control Co. Inc.**, 2 E. End Ave., New York, N. Y.

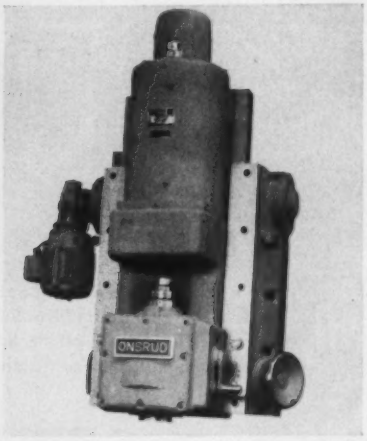
Circle 447 on Page 35



Fractional Hp Motors

Line of fractional horsepower ac motors is available in 1/20, 1/12, 1/8, 1/6, 1/4, 1/3, 1/2, and 3/4 horsepower ratings. Included in the line are open protected capacitor-start; vertical-mounted totally-enclosed, fan-cooled capacitor-start; foot-mounted totally-enclosed, fan-cooled capacitor-start; and resilient-mounted motors. These Duty Master motors feature a rolled steel frame with high-strength cast aluminum alloy end shields. Either ball or sleeve bearings are available. **Reliance Electric and Engineering Co.**, Product Information Dept., 24701 Euclid Ave., Cleveland 17, Ohio.

Circle 448 on Page 35



Milling Head

Milling head for either machine replacement or new machine installation provides a choice of 20 or 24 different spindle speeds through gear train drive and selection for milling all materials in the ferrous to nonferrous metal range. MH-50 series spindle head is built in two basic types. The first type has a speed range from 12½ to 1250 rpm; the second, a speed range from 18 to 1783 rpm. The units may be easily installed on a wide range of milling machines for high-speed milling of all standard metals and alloys. Two speed drive motors are available with a 25-50 hp rating. A right angle attachment can be supplied for mounting a milling cutter at a 90-degree angle to the main spindle axis. Spindle speed for milling is obtained by setting a gear position change lever. A dial speed indicator shows selected speed position, preventing operator error. **Machine Tool Div., Onsrud Machine Works, Inc.**, 7714 Lehigh Ave., Niles 48, Ill.

Circle 449 on Page 35

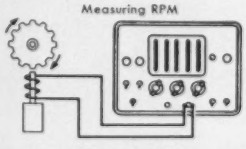
ELECTRO MAGNETIC PICKUPS

WHAT THEY ARE ... a self-generating frequency source providing the connecting link between mechanical motion and instrumentation.

WHAT THEY DO ... without contact, pickups generate frequency/voltage proportional to speed of any ferrous metal objects interrupting their magnetic fields.

1 of 1000's of applications. Wide variety of stock models for immediate delivery. Unlimited variations available on special orders.

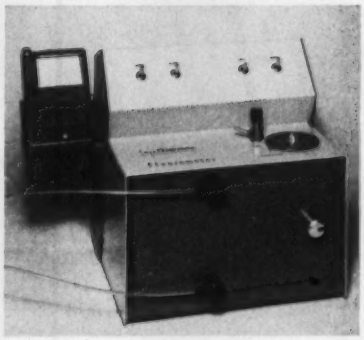
For most any application . . . Sizes as small as ¼" dia. x 1" long . . . Weights from .2 oz. . . . Operating temperatures up to 800° F.



Write for New Bulletin CMP-50

Electro CHICAGO

ELECTRO PRODUCTS LABORATORIES
4501-A North Ravenswood, Chicago 40
Canada: Atlas Instrument Corp., Ltd., Toronto, Ontario



Recording Fluorometer

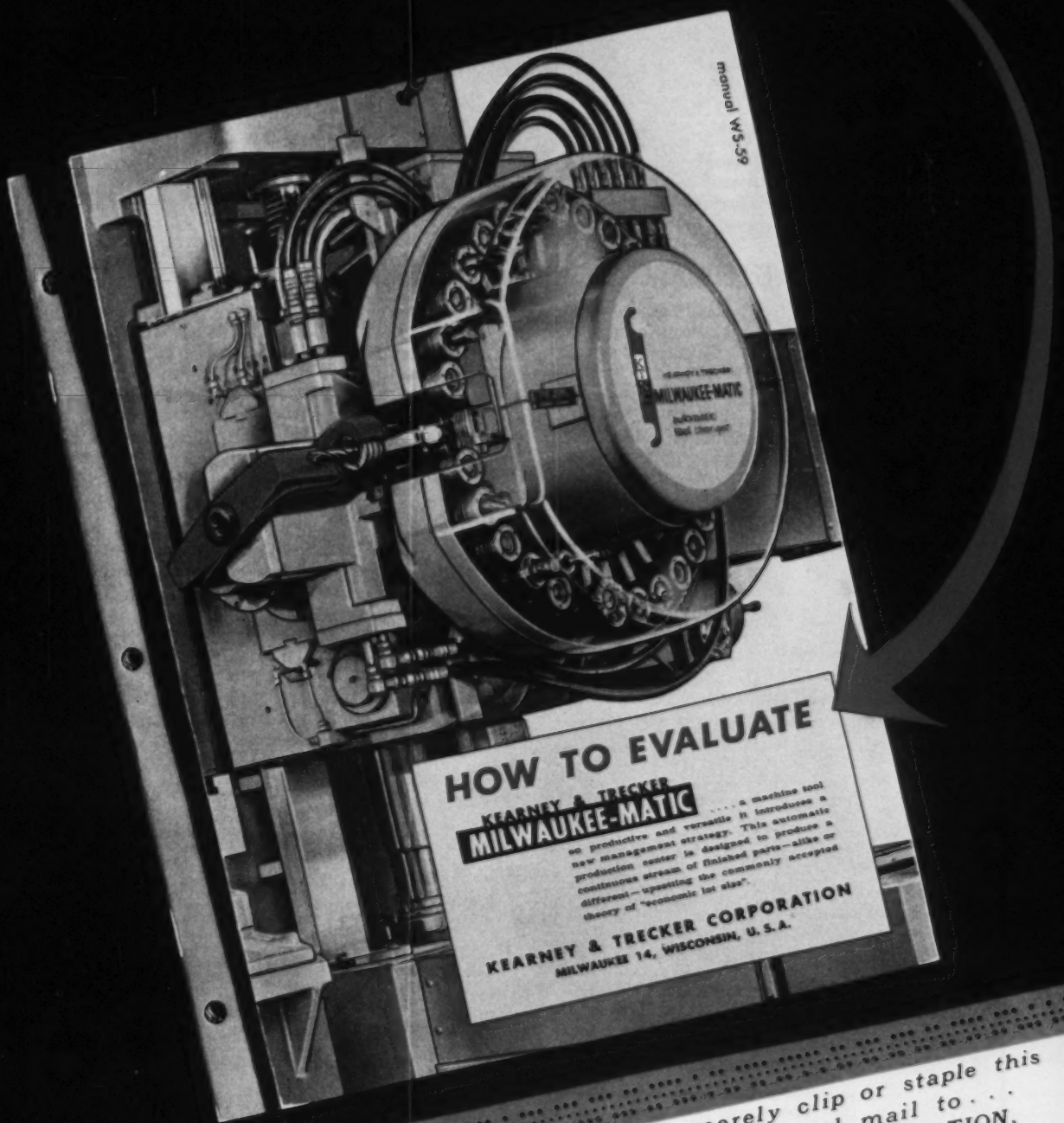
Recording/controlling fluorometer, Model 111, provides output signals suitable for continuous recording or for use with automation control equipment. Sensitivity is 2 parts per billion of quinine sulfate. Stability is ±2 per cent full scale from 105 to 130 volts and 50 to 60 cycles per second input. Applications are possible in such areas as oceanography, sewage disposal, meteorology, clinical and research medicine, metallurgy, petroleum exploration, industrial hygiene, and lubrication engineering. Seven different types are available for use with cuvettes, standard pellets for uranium analysis, paper chromatogram or electrophoresis strips, and continuous-flow meas-

To Justify

KEARNEY & TRECKER MILWAUKEE

Numerical Control

Send For This Manual


manual WS-59
MILWAUKEE-MATIC
HOW TO EVALUATE
KEARNEY & TRECKER
MILWAUKEE-MATIC
. . . . a machine tool so productive and versatile it introduces a new management strategy. This automatic production center is designed to produce a continuous stream of finished parts—alike or different—upsetting the commonly accepted theory of "economic lot size".
KEARNEY & TRECKER CORPORATION
MILWAUKEE 14, WISCONSIN, U.S.A.

For your copy of manual WS-59, merely clip or staple this coupon to your letterhead - sign and mail to . . .

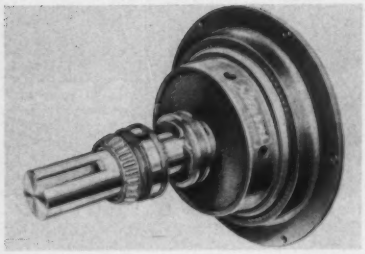
KEARNEY & TRECKER CORPORATION,
6800 W. National Avenue,
Milwaukee 14, Wisconsin

Circle 708 on Page 35

urements of fluids in various volumes. **G. K. Turner Associates**, 2524 Pulgas Ave., Palo Alto, Calif.

Circle 450 on Page 35

Multiple Disc Clutch

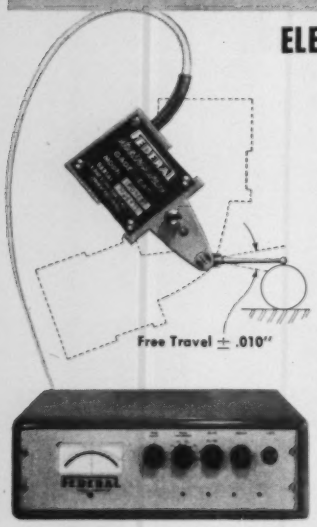


Electromagnetic multiple disc clutch features friction elements that are placed on the outside diameter of the magnet body. In this manner a longer torque arm is possible for a given size unit, and friction area is comparatively greater. Style *F* clutch is available with 2, 4, or 6 disc friction surfaces. Principal advantage of design is its adaptability to mount in certain engine housings and power take-off units. Proposed sizes are on the order of 7, 9, 13, and 15-inch diameters with torque ratings up to 4000 lb-ft. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

Circle 451 on Page 35

GAGE PAGE

A Quick Run-down of New Gaging Ideas



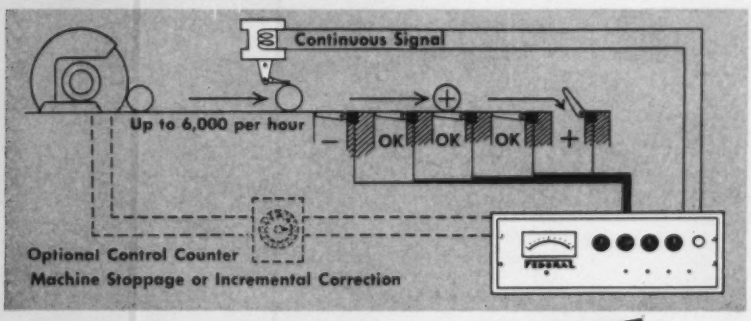
ELECTRONIC GAGING — *Economically*

Small Electro-Probe Gage Head for bench or automatic applications.

Highly versatile . . . Overtravel protected . . . Virtually frictionless response . . . Feather-light contact-pressure (less than 2½ grams) simplifies support design . . . Mounts in any position . . . Only 1½" x 2½" x 2³⁄₃₂" thick . . . Impervious to oil and water . . . Works with variety of Amplifiers and combined Amplifier-Classifiers.

— for example 230M-27 (pictured) provides 8 gaging ranges . . . min. grads. from .000010" to .002" . . . Center zero meter . . . Four control limits which can be preset from panel . . . Classifies into five size categories, e.g. "over", "under", and three classifications of "good". — This precision combination for about $850.

Gage Head with dual-range Amplifier is less than $500.



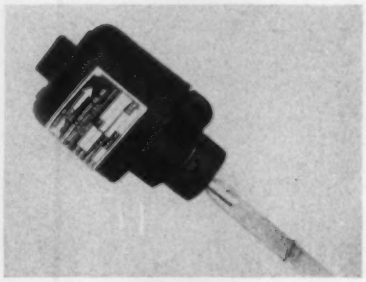
For complete specs, dimensions — the *whole* story — send for Catalog 60 AM.

FEDERAL PRODUCTS CORPORATION
1392 EDDY STREET, PROVIDENCE 1, R. I.

Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging



Electrical Switch

Flow actuated electrical switch can start and stop pumps, valves, alarms, signals, or controls in all related operations such as mixing, blending, filling, and emptying. It is made to fit lines from ¼ to 60 inches in brass, bronze, steel, and stainless steel. Available in a wide variety of electrical switching arrangements and capacities, this switch is leakproof and does not use packing glands or stuffing boxes in its construction. **Power Equipment and Engineering Co. Inc.**, 1826 213th St., Torrance, Calif.

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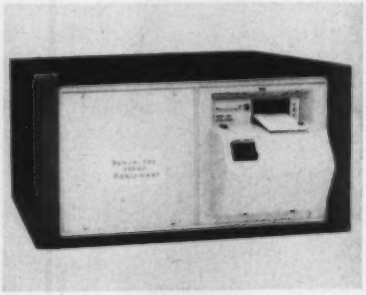
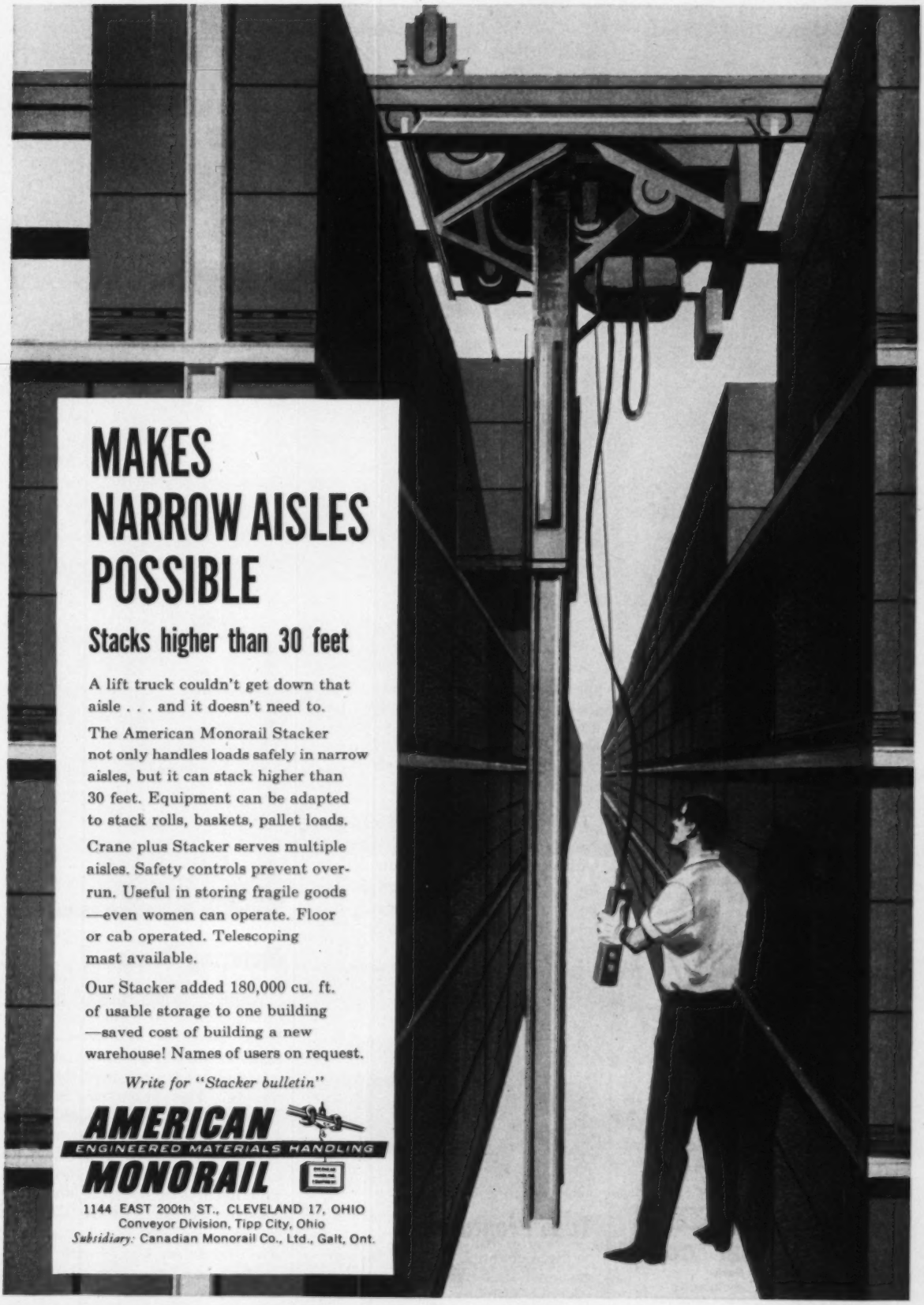


High-Speed Printer

Unit is designed to record the readings of a specific line of counters. It prints up to 12 digits at high speeds on paper tape and delays the counter only 1/5 second to collect



MAKES NARROW AISLES POSSIBLE

Stacks higher than 30 feet

A lift truck couldn't get down that aisle . . . and it doesn't need to.

The American Monorail Stacker not only handles loads safely in narrow aisles, but it can stack higher than 30 feet. Equipment can be adapted to stack rolls, baskets, pallet loads.

Crane plus Stacker serves multiple aisles. Safety controls prevent overrun. Useful in storing fragile goods —even women can operate. Floor or cab operated. Telescoping mast available.

Our Stacker added 180,000 cu. ft. of usable storage to one building —saved cost of building a new warehouse! Names of users on request.

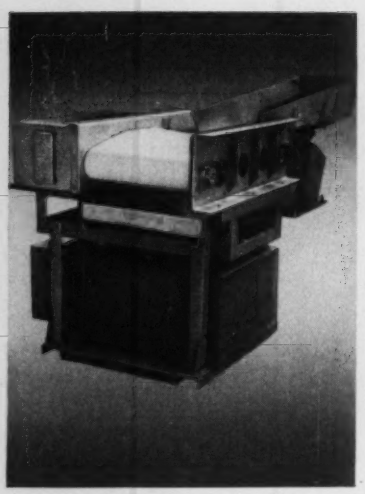
Write for "Stacker bulletin"

AMERICAN MONORAIL

ENGINEERED MATERIALS HANDLING

1144 EAST 200th ST., CLEVELAND 17, OHIO
Conveyor Division, Tipp City, Ohio
Subsidiary: Canadian Monorail Co., Ltd., Galt, Ont.

Circle 710 on Page 35



CUT
PROCESSING
COSTS

Automatic Thayer Scale Controls 3 Ingredients in Cranberry Sauce Processing, Cuts Handling Costs and Increases Profits.

Costly, time consuming measuring, feeding and blending operations in the making of cranberry sauce have been mechanized with 1 Thayer Scale. Now a Thayer Metering Scale continuously feeds cranberries, at precise rates, to the cooking process. In addition, the scale automatically controls the 2 other ingredients required, resulting in better product quality and uniformity at lower handling costs.

Unlike conventional scales, the Thayer Scale has no knife edge pivots to wear and cause inaccurate weighing. The Flexure-Plate suspension system of the Thayer Scale cannot wear, requires no maintenance, and accuracy is guaranteed for millions of weighings.

Thayer engineers will inspect your product and production process and demonstrate how your costs can be reduced by more accurate weight control.

Write for information on BAGGING, BATCHING, METERING and CHECKWEIGHING SCALES.

THE Thayer SCALE

THAYER SCALE CORP.
3 Thayer Park
Pembroke, Massachusetts
A Subsidiary of Sundstrand Corporation

Circle 711 on Page 35

count information. Readings will be printed in black or red on command, making it possible to distinguish between two sets of data on the same tape. Model 1453 may be actuated by a standard 1248 binary code as well as the 1224 code generated by the counters. This compact printer occupies one-half of a 19-inch rack space with a panel height of 8¾ inches. It may be obtained in an individual cabinet for bench use. **Berkeley Div., Beckman Instruments,** 2200 Wright Ave., Richmond, Calif.

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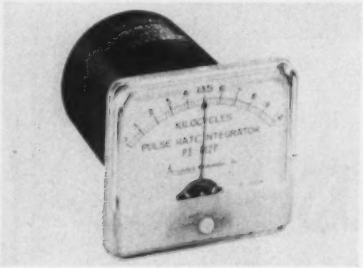
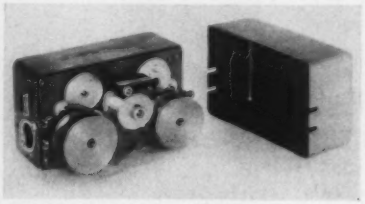


Frequency Monitor

Unit is designed for monitoring power line frequencies, turbine flow sensors, tachometers, rotating machinery, repetition rate pickups, radiation detectors, and other frequency generating devices. Designated Series PI-111 Pulse Rate Integrator, it features an input sensitivity as low as 10 mv rms. Standard models are available to indicate 57 to 63 cps and 380 to 400 cps. Variations are also available with center frequencies from 50 cps to 50 kc. All models feature 0.1 per cent resolution. **Anadex Instruments Inc.,** 14734 Arminta St., Van Nuys, Calif.

Circle 454 on Page 35



Tape Programmer

Eight-channel, punched tape programmer uses standard 1-inch wide teletype Mylar punched tape. Standard punches perforate the tape on 0.1-inch centers along the tape. Sprocket holes are punched for each line; code holes are punched as required for programming. The punch advances the tape 0.1 inch each time a line is perforated. No measurement other than counting the lines is necessary to locate a particular code hole. Tapes can be automatically reproduced with a combination reader and punch. Standard tape speed for Model TP-860 is 1 inch per second. Programs can be controlled in 0.1 second increments from zero time through the full length of the tape stored. Tape capacity is 100 feet of 0.002-inch thick tape. Separate motors are used for forward drive and rewind. Power input of the programmer is 115 v, 60 cycles, single phase. Contacts are spring type rated at 0.400 amp resistive. **Electronic Engineering Company of California,** 1601 E. Chestnut Ave., Santa Ana, Calif.

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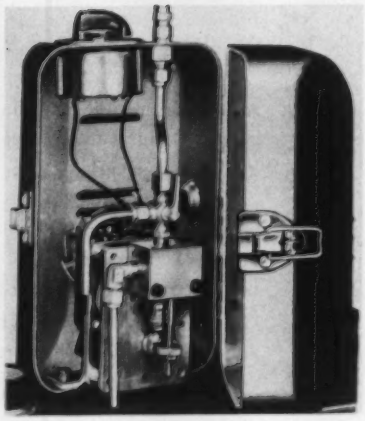
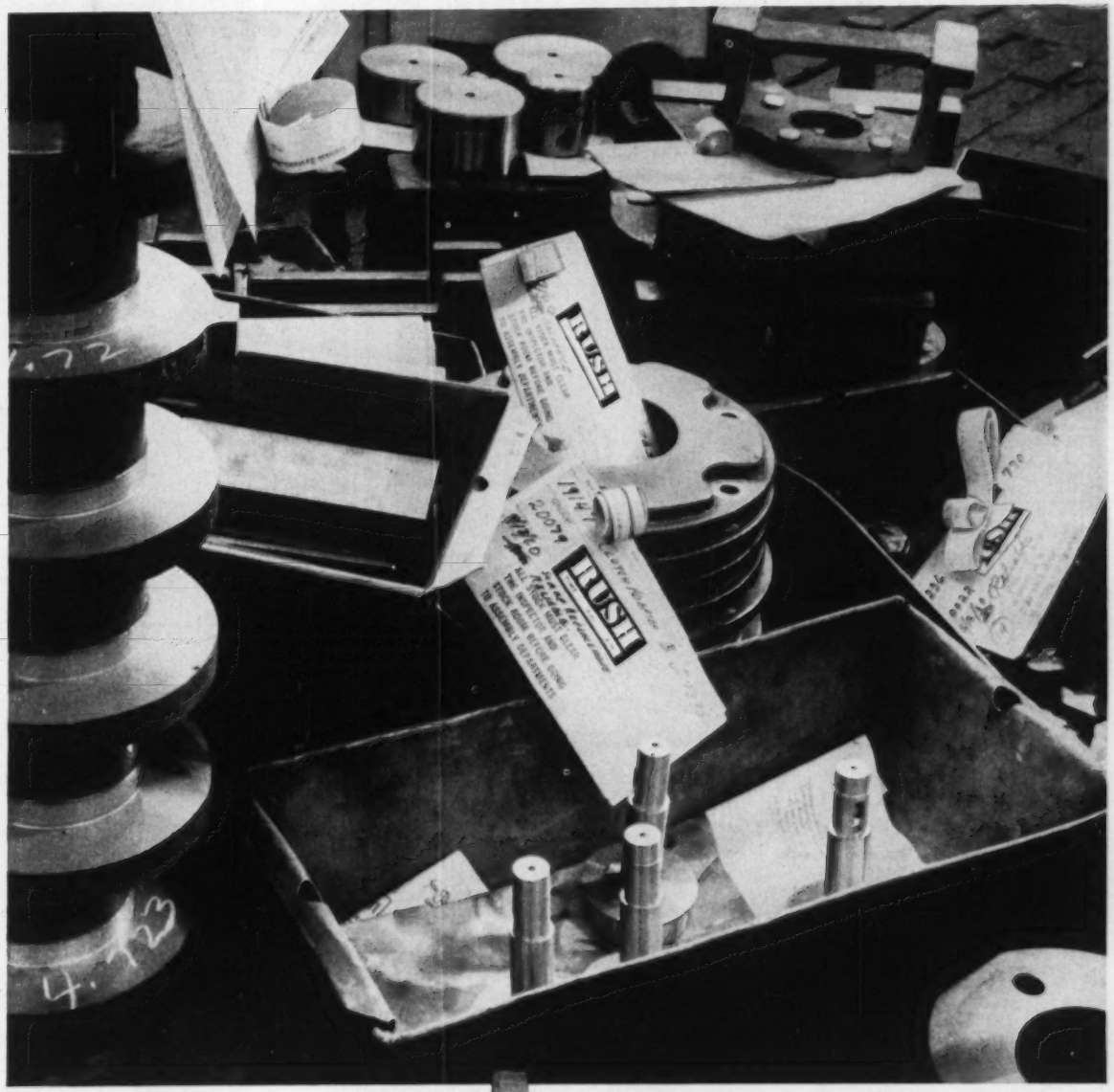
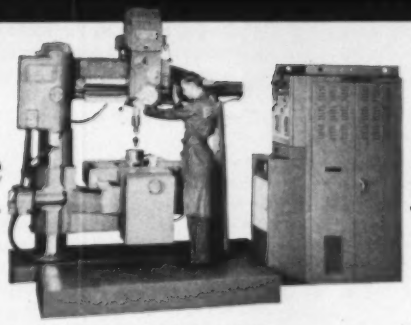


Metering Pump

Positive displacement motor driven pump is adaptable to a broad range of applications—particularly precise pumping, measuring, and lubricating involving clear liquids. This pump can move as little as one drop of liquid every five minutes or as much as one pint per minute, and is available with an electronic timer. It has many experimental or research laboratory uses. Standard 110 or 220 volt model is made of metal, noncorrosive to ordinary liquids with stronger than usual corrosive qualities. It is capable of operating under a



The Indispensable  Drilling Machine

In every shop there is one machine tool you "can't get along without". This new Numerically Controlled Layout Drill is that kind of machine tool.

It's simple, easy to operate.

Fast, 3 seconds average, hole-to-hole. Accurate, ± .002″ on location. Handles big work (24″ x 42″ table). General Electric Mark II numerical control system with full zero offset.

It's your best buy in numerically controlled drills. We say it's indispensable. In our own shop this Fosdick N/C Layout Drill eliminated the need for 250 fixtures in one ten-week period. In that short time it more than justified its cost. It can do the same for you.

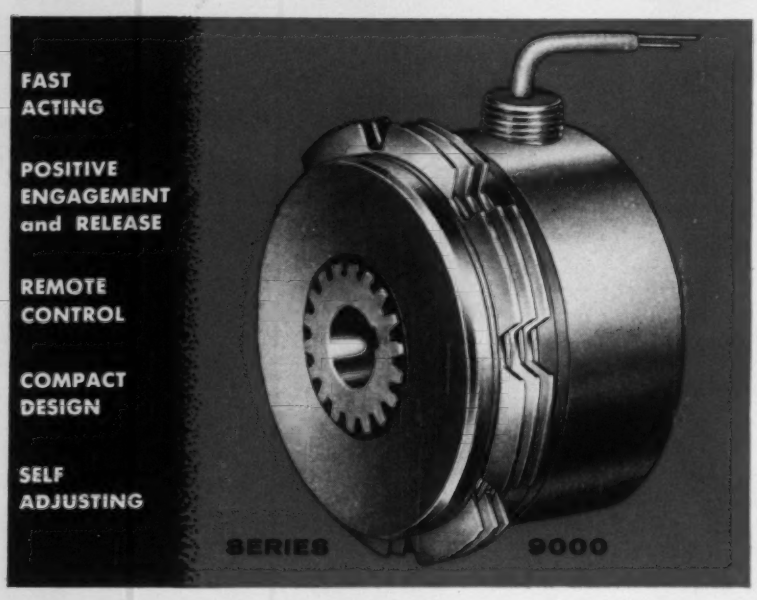
Get a proposal from Fosdick.

FOSDICK

The Fosdick Machine Tool Company
Cincinnati 23, Ohio

Circle 712 on Page 35

IDEAL FOR AUTOMATED MACHINES



Maxitorq
ELECTRIC
CLUTCHES and BRAKES

Incorporating advanced design principles proved through years of service, the MAXITORQ Electric Clutch is well adapted to all types of machine drives. Simple in design . . . built to machine tool standards . . . requires no adjustments, can be used either as a clutch or brake. Disc separators not only separate discs, but also break up residual magnetism and result in extremely fast, positive action with no drag or heating in neutral. There are few moving parts. Electrical operating unit remains stationary — hence, no troublesome slip rings, brushes, or difficult wiring problems. Operation is on standard 100 V a.c. Other voltages on special order.

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us. Phone, wire, or write Dept. AT for Bulletin No. 90.

SPECIAL FEATURES

Engaged entirely by magnetic flux.

Operate either on-off or by varying voltage for torque control.

NO troublesome slip rings or brushes.

NO levers, cams, or other highly stressed mechanical parts.

Operation is not dependent upon rotation.

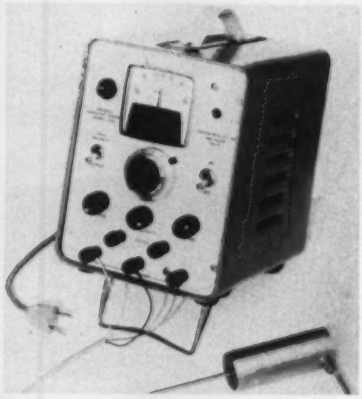
Finished complete, assembled, and ready to install on shaft.

THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

ICJ61

variety of heads or pressures. **Pump Div., Bomar Laboratories Ltd.,** Sheridan Road at Winona, Chicago 41, Ill.

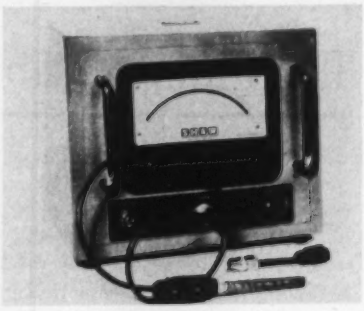
Circle 456 on Page 35



Indicator System

System is designed to combine high accuracy, portability, and operation from any 110 volt 60 cps power source. It provides for remote indication of displacement or liquid level and will indicate at distances up to 1000 feet. Transducers are available for use with the indicator with strokes from ½ inch up to 10 feet. Accuracy is ±0.2 per cent. Kavlico indicator system, Model 201A provides dc output for recording and control and will measure displacement down to 0.0005 inch with an external recorder. **Vinson Mfg. Co.,** 8044 Woodley Ave., Van Nuys, Calif.

Circle 457 on Page 35



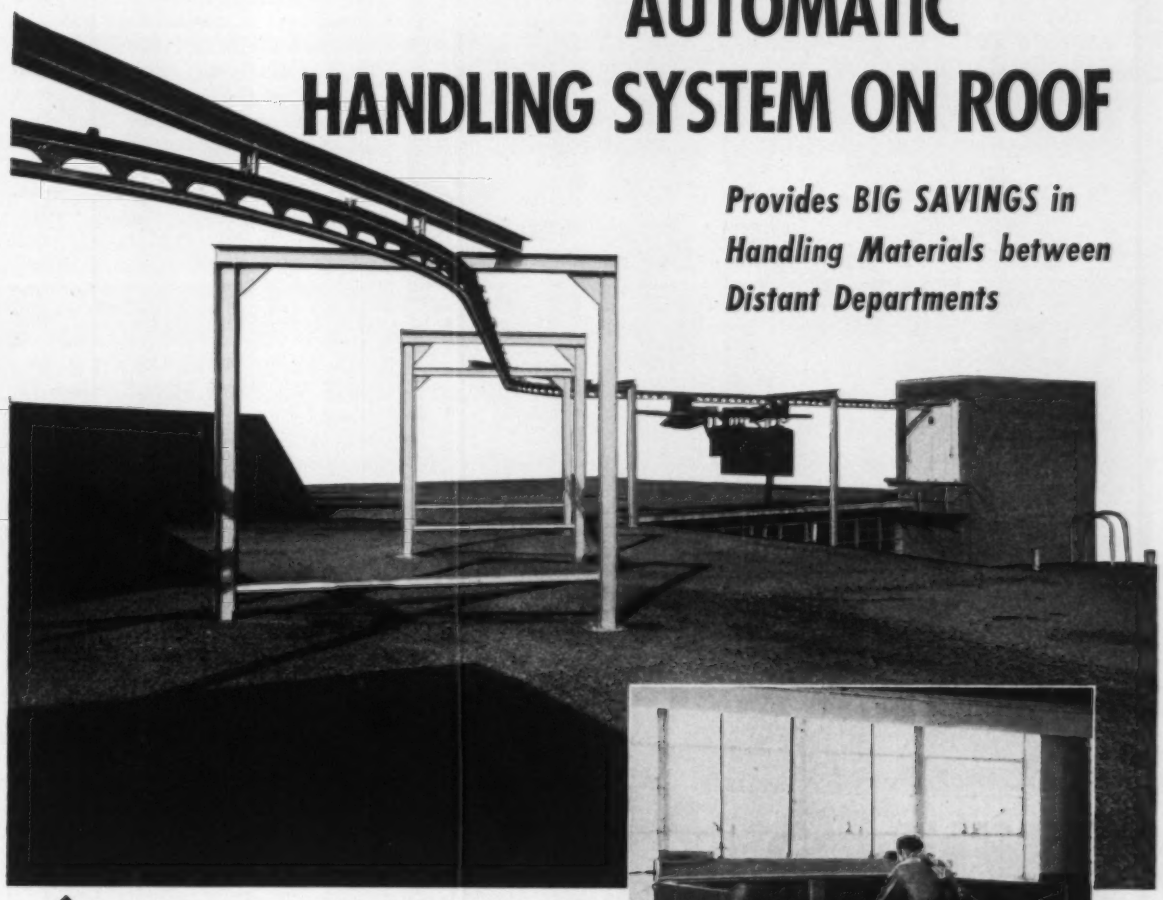
Humidity Instruments

Line of relative humidity and dewpoint instruments is designed for measuring dewpoints as low as −150 C. Instrumentation is suited

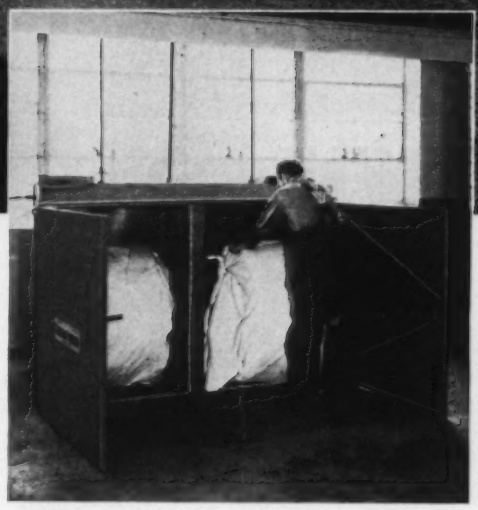
Circle 713 on Page 35

AUTOMATIC HANDLING SYSTEM ON ROOF

Provides BIG SAVINGS in Handling Materials between Distant Departments



The Tramrail carrier seen here is approaching one of the penthouses built at each end of the track. The penthouse doors open and close automatically as the carrier passes through. The load lowers to the floor inside.



Loading Tramrail freight van inside building. At a touch of a button, it hauls heavy loads long distances, day or night, through heat or cold, rain or shine, dependably, at low cost.

NEARLY every plant has thousands of square feet of idle roof area, yet their working areas may be starved for floor space.

Using the roof for materials handling by means of an automatic Cleveland Tramrail system can be a big help in relieving a crowded plant. And the roof need not be flat. Even a saw-tooth or gabled roof can be used to support a Tramrail track.

The automatic system illustrated here brought about tremendous savings. It, in effect, joined two factory departments and enabled as efficient an operation as though they were physically adjacent. It reduced the handling cost to the barest minimum because the Tramrail carrier shuttles back and forth without need of attendants. It eliminated other overhead expenses.

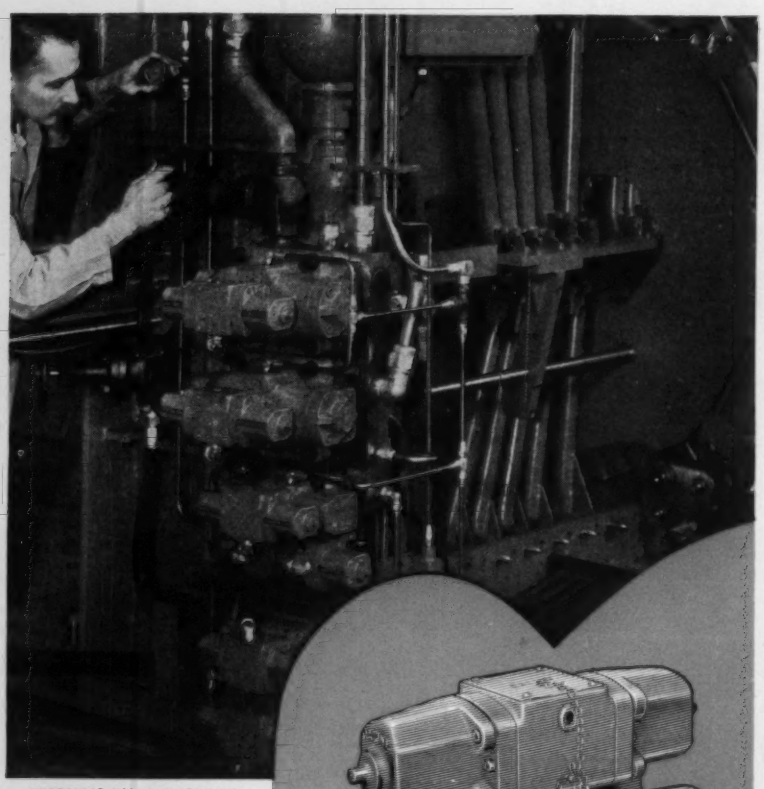
Cleveland Tramrail engineers have had wide experience in the design and application of automatic materials handling systems and will be happy to discuss ways of helping you without obligation.

Write for free "Automatic Handling" Booklet.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1351 E. 290 ST. • WICKLIFFE, OHIO

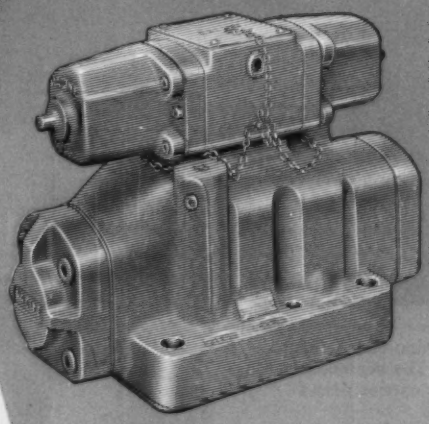


HYDRAULIC VALVE SYSTEM OF WIRE-FORMING MACHINE BUILT BY RESEARCH DESIGNING SERVICE, INC., CENTERLINE, MICHIGAN

during set-up and at 3000 springs per hour

RELIABLE VALVES DIRECT THE POWER OF A HYDRAULIC HEART

"Control of all our hydraulic operations is vital, and this is possible with RACINE equipment," says Bill Karolle, electrical engineer with Research Designing Service, Inc. "Our hydraulic machines are used to form wire for 80% of all automobile seat springs." As oil requirements change constantly during set-up operations, 6 RACINE DIRECTIONAL CONTROL VALVES guide the *right oil volume* at the *right pressure* to the *right place* at the *right time*. At high production speeds, these 4-way, solenoid-controlled valves maintain the pre-set wire forming pattern with absolutely uniform precision. Valve reliability is important since these machines may perform over five million cycles during their lifetime.



6 RACINE

Directional Control Valves guide hydraulic wire-forming operations of this machine

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

HYDRAULICS DIVISION

Circle 715 on Page 35

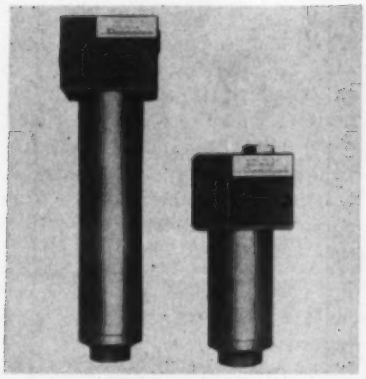
for continuous read-out or random sampling of atmospheres and has a sensitivity of one part in 10 million. Calibration may be accomplished or checked in static air or gases as readings are independent of flow rate. Sensing device is unaffected by most dust conditions and atmospheres. Stable sensing probes, with a life of several years, are available for measurements under pressures up to 2000 psi. Four standard instrument scale calibrations are available and a variety of sensing probes with connecting cables in any length. **Atkins Technical Inc.**, 1276 W. Third St., Cleveland 13, Ohio.

Circle 458 on Page 35

Control Panels

Series of packaged Protectal control panels have been developed for automatic start, stop and complete combustion supervision of gas-fired ovens, furnaces, boilers, and other heating and heat-treating systems. Basic units are for 230 v, 3 phase, 60 cycle operation. They are designed to be integrated into existing heating systems or for OEM use in new installations to standardize or upgrade safety and electrical control. Optional branch and group circuit protection is available when additional motors are used. Optional Telefier Flame-Fault indicators can be incorporated into the panels (or remotely) to provide numerical readout of faulty burner position in the event of flame failure in multiburner installations. **Protection Controls Inc.**, 7317 N. Lawndale Ave., Skokie, Ill.

Circle 459 on Page 35



Servo Filters

Instruments are designed to give a choice of either 10 or 20 gpm flows using a single size filter element of either 5 or 25 micron rating. The 10 gpm filter uses one cartridge; the 20 gpm filter uses two cartridges. Manifolding provides for unlimited flow rates. The filters have a 3000 psi pressure rating and may be used with standard hydraulic oils, MIL-O-5606 oils, and phosphate ester base oils. Connections are standard ½-inch NPTF. AND-10050 or subplate connections can be furnished. **Boonshaft and Fuchs Inc.**, Hatboro Industrial Park, Hatboro, Pa.

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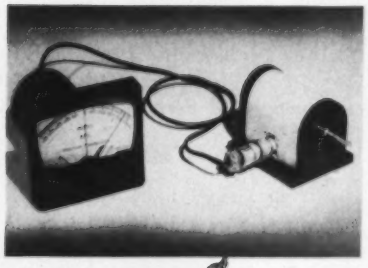


Linear Transducer

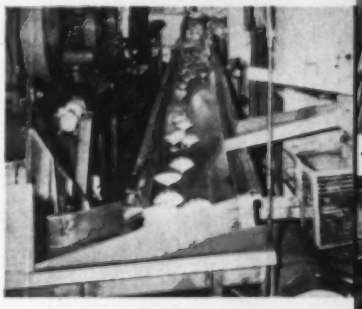
Unit is available separately, but preferably offered in combination with either a conventional panel meter or a meter-relay to form a measuring or controlling system. Sensitivity of the system is ±0.005-inch full scale. Maximum readout speed is about one per second. When a constant voltage transformer is used, full scale meter accuracy is ±0.0002-inch, and reproducibility is ±0.0001-inch. Normally the meter is calibrated for easy readability, with a mark for each 0.0001-inch.

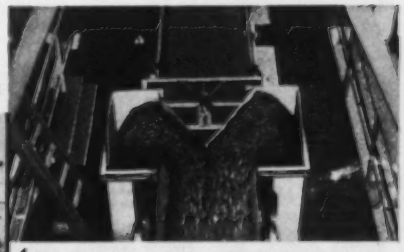
IT WILL, IF THESE ADVANTAGES ARE IMPORTANT TO YOU.

- *A strong, impermeable conveying surface of solid steel that —*
- *Resists oil, heat, impact and abrasion*
- *Lets products ride or slide, simplifying live backlogging and automatic discharge.*

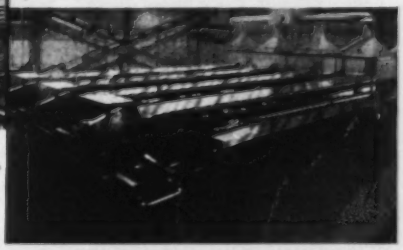
For more information without obligation write or phone your nearest Sandvik office.

Handling Bulk Materials ▶





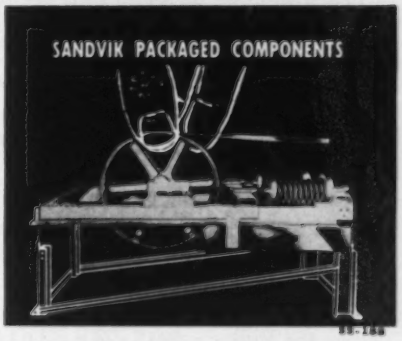
◀ Handling Metal Parts Up An Incline



Sandvik Water-Bed Conveyors Cooling & Solidifying Chemicals ▶

You Can Buy It Complete Or Build It Yourself With

In addition to complete, custom-engineered steel belt conveyors, Sandvik supplies conveyor components in packaged unit assemblies. For example, from Sandvik you can buy the tension end assembly, drive end assembly, steel belt, idlers and discharge devices and Sandvik will provide engineering assistance to help you build or convert to a steel belt conveyor.



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Manufacturers of Steel Belt Conveyors for Over 40 Years.

Circle 716 on Page 35

Fall River Line Pier, Inc. installs new

TOLEDO ELECTRONIC TRUCK SCALE

with **PRINTWEIGH® "400"**

"speeds up weighing, provides accurate printed weights"
says William J. Torpey, General Manager

"Truck weights up to 50 tons are instantly transmitted *electronically* from the full-length 60′ scale platform to the weighing head located in the pier office. There, the weight records are automatically printed in triplicate on certified weight tickets. Our Toledo Printweigh "400" eliminates human error, speeds weighing and assures more accuracy than ever before on any scale, to trucker and customer alike."

TOLEDO's complete truck scale line gives you a full choice of capacities and platform sizes in mechanical or electronic type scales. Printweigh recording on forms, tickets or strips may be at the scale or a remote location. Many more advanced TOLEDO features are offered to speed weighing, eliminate human error. For full details, write for Bulletin 2417, TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio. (Toledo Scale Co. of Canada Ltd., Windsor, Ontario)

SERVICE Factory-Trained 240 Cities

TOLEDO®

Greatest name in weighing

Circle 717 on Page 35

When only indication of the signal is required, a panel meter is used with the transducer. If control of an operation is also desired, the transducer may read out to a meter-relay, either continuous reading or locking contact type. Digital read-out may be obtained with a Liad meter-relay. **Assembly Products Inc.**, Chesterland, Ohio.

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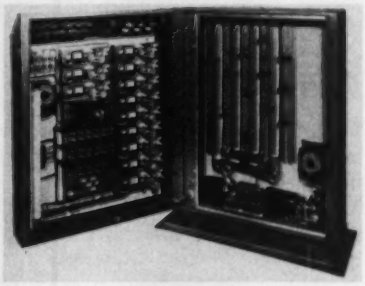
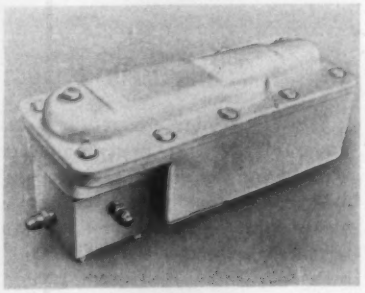


Memory Control System

Self-contained, closed-loop magnetic tape memory control system for handling intelligence is applicable to random dispatching of material on conveyors or control of machinery. Input intelligence is accepted from pushbutton or automatic sensing devices. The Mem-O-Trol system has direct or selsyn drive as well as infinite adjustability of channel components. Optional features include remote control, item centering device, and item spacing control. **Edon Industrial Products**, 4412 Fernlee, Royal Oak, Mich.

Circle 462 on Page 35



Signal Converter

Electro-pneumatic converter has been developed to convert dc voltage or current into a pneumatic pressure signal. It will accept elec-

trical input signals of 1-9 v or milliamps dc, or 1-5 v or milliamps dc. Pneumatic output signal ranges are 0-30, 0-15, 3-27, 3-15 psi, or the inverse of these ranges. With an over-all accuracy of 0.5 per cent of full scale, the PowrMag converter's electrical system is temperature compensated to maintain accuracy over a wide range of temperature conditions. The temperature coefficient is 0.25 per cent per 100 F on range and 1 per cent per 100 F on zero. Provided with a waterproof housing, the unit is unaffected by ambient temperatures up to 120 F. Frequency response of the converter is 2.5 cps; linearity is ±0.5 per cent of full scale; repeatability is 0.1 per cent of full scale; and sensitivity is 0.025 per cent of full scale. **Hagan Chemicals & Controls Inc.**, Hagan Center, Pittsburgh 30, Pa.

Circle 463 on Page 35

Bin Vibrator

Magnetic bin vibrator is capable of moving extra large quantities of hard-to-handle materials through large bins and bunkers. Feature of Model 70U (illustrated) is its double-impact system in which the vibrator's hammer strokes an anvil at both top and bottom of the stroke imparting, at 60 cycles per second, the equivalent of 7200 blows per minute against the bin wall. Semi-resilient impact elements cushion the impact sufficiently to result in semi-noiseless operation. The vibrator is designed for installations on chutes, hoppers, and variously shaped bins with walls to a thickness of ½ inch and up to 50 ton capacity. Larger bins may require two or more vibrators. For hazardous dusty locations,

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Now in full production at Robertshaw with immediate deliveries on stock models!

Our thanks to the many Acragage customers who said the best was worth waiting for . . . and who patiently waited till production could be transferred to our Knoxville plant.

Now the waiting's over, back orders have been filled—and we're guaranteeing *immediate deliveries* from stock on the most popular models of Acragage pressure, vacuum, compound and test gages.

Our design and special-order departments are also in full swing and can assure quick delivery on models made to your own requirements.

Fast delivery also available on Acragage electric and pneumatic transmitters and receivers.

See your Robertshaw representative . . . or write today for Acragage Bulletin CK-761.

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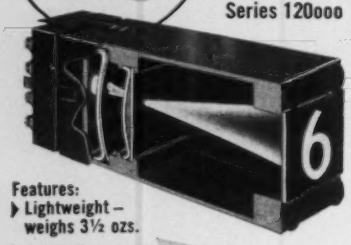
FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

Circle 718 on Page 35

MINIATURIZED! LIGHTWEIGHT!

IN-LINE DIGITAL READOUT
Series 120000



Features:
- Lightweight – weighs 3½ ozs.
- Quick disconnect at rear for easy lamp replacement.

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INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
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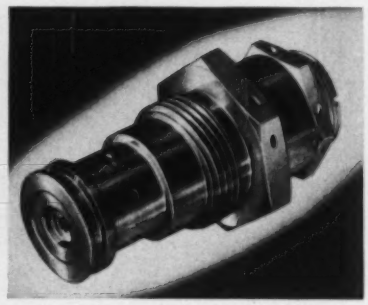
Circle 719 on Page 35

Model M70U is available with a special J.I.C. control housing. **Eriez Manufacturing Co.**, Erie 6, Pa.

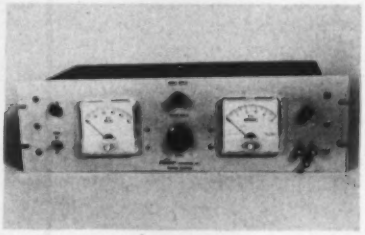
Circle 464 on Page 35



Flow Regulator

Precise flow regulation of fluids under varying pressures is made possible with this cartridge flow regulator which maintains constant flow to a system when the pump output or the upstream or downstream pressures vary. Used in a single body or a multivalve manifold, the valve is available in a range of flows varying from 0.1 to 6.5 gpm flows. An adjusting screw permits field adjustments of ±10 per cent for flows of 0.1 to 1.5 gpm and ±5 per cent for flows of 1.5 to 6.5 gpm. This regulator is built for 0 to 2000 psi operating pressure and has a pressure drop of 25 psi at high flows and 50 psi at low flows. Constructed from hardcoated aluminum and stainless steel parts, it will handle all fluids compatible with these materials. **Fluid Regulators Corp.**, 313 Gillette St., Painesville, Ohio.

Circle 465 on Page 35



Power Supplies

Designed specifically for transistor circuit applications, transistorized regulated power supply features an output of 12 v dc, 0-5 amps; transient response 50 mv or less for 50 microsec or less under square wave load conditions; no line transients; line regulation 0.1 per cent; and load regulation 0.25 per cent. Output impedance is 0.01 ohm dc-5 kc; stability 0.5 per cent or 50 mv for 24 hours after warm-up. Model PS111M has an input of 105-125 v, 60-400 cps. **Valor Instruments Inc.**, 13214 Crenshaw Blvd., Gardena, Calif.

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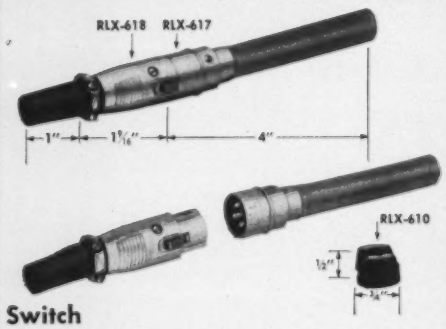
POST ELECTRONIC PRODUCTS



NEW!
MH-2-P Magnetic Switch

A new and improved sensing device . . . neatly contained in an epoxy resin shell. The MH-2-P is ideal for industrial applications and is easier to mount in areas of limited access. A quick disconnect Cannon connector eliminates elbow type construction.

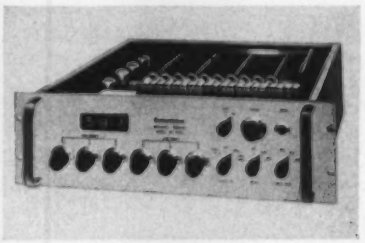
The new epoxy resin housing results in less magnetic flux and increased sensitivity. As a consequence, smaller magnets can be used and manufacturer reports a minimum magnetic field transient time of only 8 milliseconds is needed to activate the switch. Operating life is in excess of one billion operations.

Write For Bulletin MH-2-P

Decitron

POST ELECTRONIC PRODUCTS
Division of Reid Brothers Company, Inc.
12 LOTHROP ST. / BEVERLY, MASS.

Circle 720 on Page 35

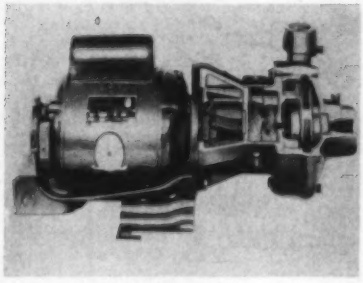


Crossbar Scanner

Designed to provide high-capacity scanning for data-logging systems, Model SD-6 crossbar scanner operates at speeds up to 50 points per second. Applications include use in data-processing systems, as a module

of computer designs; in automatic process control, as a sampling device for analog computer outputs, in power or signal distribution centers; and in the programming of automatic processes and testing devices. The device provides a 100-channel, 6-pole-per-channel capacity which can be readily altered to a 200-channel/3-pole, a 300-channel/2-pole, or a 600-channel/1-pole array through a level-scanning option. The scanner is rated at 20 million operations per crosspoint, continuous duty at full load, at extremes of rated environment. Options include internal pulse generator, visual readout, decimal readout, telephone dial, and keyboard. **James Cunningham Son & Co.**, Rochester 8, N. Y.

Circle 467 on Page 35



Stainless Steel Pumps

In both of these stainless steel pump series, the impellers are dynamically balanced to prevent shaft vibration and to extend seal life. All of the pumps have been constructed for quick assembly and disassembly. Pump seals are of Remite and are self-lubricating and leakless. Series 1522 pumps are compact in design. Thirty-six different models are available with capacities to 150 gallons per minute and heads to 120 feet. Suction and discharge connections run from ¾ by 1¼ to 1½ by 2 inches. The same sizes are available in Series 1512 long coupled construction pumps with capacities ranging up to 220 gallons per minute and heads to 120 feet. These pumps are equipped with deep grooved ball bearings and standard flexible couplings. The bearing, shaft, and impeller are self-supported on one casting. **Bell & Gossett Co.**, Morton Grove, Ill.

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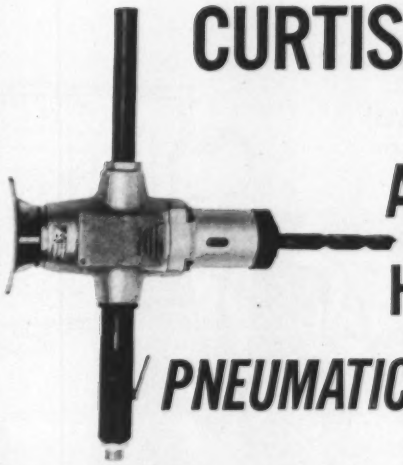

CURTISS-WRIGHT

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A NEW LINE OF HIGH QUALITY *PNEUMATICALLY OPERATED* HAND TOOLS

PNEUMATIC DRILLS — Sizes from ¼" to 1¼". Weight, ½ to ⅓ as much as comparable electric drills. Easily controlled speed, for slow starts without pre-centering.

Precision designed, pneumatically operated hand tools manufactured by the internationally known Grasso Works of Hertogenbosch, Holland, are now sold and serviced through the Marquette Division, Curtiss-Wright Corporation. Here is the complete selection of economical hand tools that combine light weight and rugged construction with high speed and excellent balance for fast, comfortable, safe operation and long maintenance-free service. For production, maintenance, and general utility work the complete line of hammers, drills, sprayers, riveters, rammers, and the all-purpose 6-in-1 COMBINAIR kit meet every industrial requirement.

GRINDERS — Small, compact, and powerful with diameters from ¾" to 9".

HEAVY DUTY HAMMERS — Available with round and hex shanks and a wide range of fittings for cutting, scaling, chipping, caulking, etc.

COMBINAIR — 6-in-1 all-purpose tool. The basic unit, with attachments, can be used for drilling, cutting, sanding, buffing, corner drilling, and polishing.

FOR INFORMATION WRITE THE MARQUETTE DIVISION, CURTISS-WRIGHT CORPORATION.

CURTISS WRIGHT

MARQUETTE DIVISION

1145 Galewood Drive, Cleveland 10, Ohio

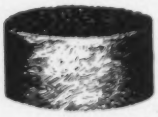
AD NO. 32-8

Circle 721 on Page 35

"Briquette this stuff and we can sell it at a profit!"

. . . with a

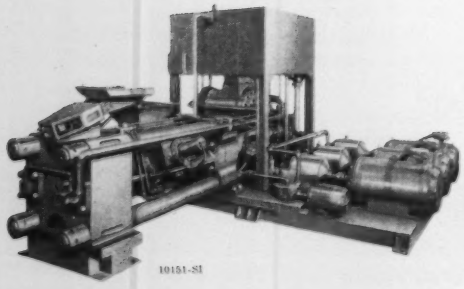
SPO-MILWAUKEE briquetting press!



As the metal working industry increases machine tool speeds . . . as automation techniques facilitate faster production . . . more and MORE chips, turnings and borings are formed.

Briquetted scrap sells for more money . . . and this means a briquetting press is a profit making machine . . . a profit unit that operates virtually "operator-free." The advantages of briquetting go even beyond profit. Your scrap will require less storage area. Briquetted scrap is easier to handle . . . cheaper to ship . . . faster to dispose of.

If your machine tool scrap ranges from 4 tons per day to 9 tons per hour, there is a Milwaukee briquetting press that will bring profit to your scrap problem.



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Circle 722 on Page 35

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 35.

Remote Control System

Femco Inc., Irwin, Pa.—2 *page pamphlet*—Bulletin 5903 provides data on a system, designated CMC, for monitoring remotely located pumps and valves in water supply systems; for telemetering water level, pressure, and flow data to a central control station; and for controlling the pumps and valves. All functions can be performed by using only a single pair of wires between the remote location and the central control station. Existing telephone lines also can be used.

Circle 469 on Page 35

Walking Beam Conveyor

Conveyor Corp., 19815 *E. Nine Mile Rd., St. Clair Shores, Mich.*—6 *page pamphlet*—Data are given in this booklet on a walking beam conveyor, designated Power-Bar. Typical uses for the conveyor such as pallet return systems, the feeding of presses, transferring between machines, or any application in which a part must be picked up, carried, and deposited in desired places repeatedly are listed. Labeled drawings are used to illustrate various applications of the unit.

Circle 470 on Page 35

Servo Valves and Systems

Industrial Div., Moog Servocontrols Inc., East Aurora, N. Y.—16 *page booklet*—Bulletin 110 describes a line of servo valves and potential applications of electrohydraulic control systems utilizing these valves. Single, two, and three stage servo valves are covered, as well as various valve types such as flow control, pressure control, pressure-flow control, and dynamic pressure feedback. Typical applications are discussed, and case histories are given.

Circle 471 on Page 35

Memory Core Handler

Rese Engineering Inc., 731 *Arch St., Philadelphia* 6, *Pa.*—2 *page pamphlet*—Bulletin 60-A contains data on an automatic memory core handler for testing miniature ferrite cores. Designated as Model CH-58, this device grades and sorts standard 80 mil or 50 mil cores at continuous operating speeds of over 16,000 cores per hour. The bulletin describes the machine's electromechanical operation for both semiautomatic laboratory analysis and full-scale production testing. A brief description is provided of Models 4021 and 4022 manual core test jigs for pilot production and laboratory testing of metallic tape wound and miniature ferrite cores.

Circle 472 on Page 35

Strapping Machines

Signode Steel Strapping Co., 2600 *N. Western Ave., Chicago* 47, *Ill.*—4 *page pamphlet*—Folder SPD-246 describes and illustrates a series of electric-powered strapping machines, designated M-20. Strap tension is preselected from a range of 50 to 1500 lb. A chart gives characteristics of each of the four standardized general-purpose machines, the M20-A for hardwood flooring, and the M20-RB for end binding of paper rolls up to 72 inches in diameter. Other models in the series accept package sizes from 1 by 3 inches to 20 by 24 inches.

Circle 473 on Page 35

Nylon Tubing

Plaskon Nylon Sales, Plastics and Coal Chemicals Div., Allied Chemical Corp., 40 *Rector St., New York* 6, *N. Y.*—16 *page booklet*—Bulletin 84-47 provides a detailed description of the properties, installation techniques, and performance characteristics in the instrument-air service of nylon tubing. This tubing is used in many industrial applications such as centralized lubrication systems on heavy machinery, air supply on printing presses, automobile air-suspension systems, and automobile lubrication systems. Several installation techniques developed for the material are provided.

Circle 474 on Page 35

Stream Analyzer

Brookfield Engineering Laboratories Inc., Stoughton, Mass.—2 *page pamphlet*—Bulletin provides information on a device designed to permit the removal of fluid from a pressurized line, measurement of its viscosity, and its return to the line. This stream analyzer is useful in asphalt blending, asphalt blowing, and lube oil blending operations, as well as other applications in the chemical processing or petroleum field. It produces a steady flow of 1 gpm through a sampling chamber in which the viscosity measurement is made. The system will handle material up to 550 F. Maximum line pressure is 150 psi.

Circle 475 on Page 35

Geared Speed Reducers

U. S. Electrical Motors Inc., P. O. Box 2058 *Terminal Annex, Los Angeles* 54, *Calif.*—12 *page booklet*—Bulletin F-2003 describes and illustrates a line of shaft-mounted Synchrogear speed reducers. Tables show the service classifications to be applied in determining the types of speed reducers to be used in various applications and under various conditions of usage. Bulletin also provides data on frame size selection based on service class, horsepower, and output speed. A cut-away photo illustrates 12 special features of the Synchrogear. Descriptions are included of an optional, nonreverse backstop and an overload release unit.

Circle 476 on Page 35

Magnetic Coolant Separators

Barnes Drill Co., 830 *Chestnut St., Rockford, Ill.*—8 *page bulletin*—Catalog 300-D provides detailed information on BarnesdriL magnetic separators. Operation of the separators is explained, and installations are illustrated. Various models are designed to clean dirty coolant in flows ranging from 1½ to 120 gpm. Applications include all types of grinders, honing machines, gear shavers, broaching machines, thread rolling machines, milling machines, and deep hole drills.

Circle 477 on Page 35

Variable Speed Drives

Zero-Max Co., 1900 *Lundale Ave. South, Minneapolis* 5, *Minn.*—16 *page booklet*—Catalog ZM-400C760 covers a line of stepless, variable speed drives that are available in 35 basic fractional hp models through ¾ hp and speed ranges from 80-0-80 to 1200-0-1200 rpm. Torque ratings are available from 3 through 450 lb-in. Construction details of the new 400 Series are indicated by diagrams.

Circle 478 on Page 35

Design and Build Service

Gros-Ite Industries Inc., Route 6, *Farmington, Conn.*—8 *page bulletin*—Brochure describes research, design, development, engineering, manufacturing, inspection, and production services offered by this company. These services can be applied to virtually any industrial tooling or machinery application such as assembly, au-

tomotive tooling, and sheet metal production equipment. Typical application photographs are provided.

Circle 479 on Page 35

Visual Control System

Methods Research Corp., 105 Willow Ave., Staten Island 5, N. Y.—12 page booklet—Brochure contains data on a visual control system which is essentially a magnetic steel board on which visual aids are placed to give important facts quickly. Applications include such uses as production control, scheduling, machine loading, and personnel control. Typical line, bar, and organization graphs are described and illustrated.

Circle 480 on Page 35

Stepping Switches

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.—40 page catalog—Line of stepping switches is subject of Catalog 202. Complete data on construction features, circuitry, and performance characteristics of spring-driven, cam-operated, and direct-drive stepping switches are given. Mounting accessories and sealed and dust-cover enclosures are pictured and described. Helpful information for proper switch selection is included.

Circle 481 on Page 35

Vacuum Handling Systems

Whiting Corp., Harvey, Ill.—3 pamphlets—Line of vacuum handling systems, designated Pressuregrip, is described in Bulletins V-100-R, V-101, and V-102. Operation of these systems depends on atmospheric pressure. They are ideal for handling materials such as concrete beams, aluminum ingots, stainless steel sheets, and timber. The line now includes Uni-Grip, a modular type system. Six different attachments, each designed to perform a variety of jobs within a 2000 lb capacity limit, can be accommodated interchangeably with the new system.

Circle 482 on Page 35

Heat Processing Equipment

Selas Corp. of America, Dresher, Pa.—16 page booklet—Bulletin S-1058 describes machines for heat treating, selective hardening, brazing and soldering, annealing, and other processes for heating metals. Typical applications and equipment illustrated include electric motor rotor postheating, austempering typewriter parts, sledge hammer harden-and-draw line, heating for forging ferrous and nonferrous bars and slugs, brazing of aluminum utensils, and shell mold curing. Illustrated diagramatically are components for controlled combustion systems utilizing high-speed gas heating equipment for semi-enclosed or enclosed heating.

Circle 483 on Page 35

Resistance Welding Transformer

Kirkhof Mfg. Corp., 2450 Buchanan Ave., S.W., Grand Rapids 7, Mich.—8 page bulletin—Bulletin T60-1 contains data on a line of Epoxy-Pak resistance welding transformers. Featured construction detail of the devices is epoxy impregnation and encapsulation which provides up to 33 per cent greater power capacity, plus longer weld cycles, better overload protection, and longer operating life. Details on nine basic units are provided. For high production operations, these transformers are capable of withstanding a heat rise of 110C.

Circle 484 on Page 35

Radiation Equipment

Radiation Instrument Development Laboratory Inc. 61 E. North Ave., Northlake, Ill.—92 page catalog—General Catalog 61 contains information on a line of radiation detecting and measuring instruments, including counters and detectors, amplifiers, analyzers, high voltage power supplies, recorders, electronic timers, and scalers. Accessories such as shields, phototubes, and timers are also covered. Photographs accompany various item descriptions.

Circle 485 on Page 35

Safety Enclosures

Kewaunee Scientific Equipment, 4021 Logan St., Adrian, Mich.—32 page catalog—Catalog AIA 35 E contains data on a line of safety enclosures. Described and illustrated in the booklet are glove, vacuum, and dry boxes and controlled atmosphere systems for research and production purposes. Details are provided on a CBR-LABS system, specifically designed and arranged to act as a basic building block upon which laboratories can initiate and practice various types of laboratory techniques. Special enclosures and accessory equipment are covered.

Circle 486 on Page 35

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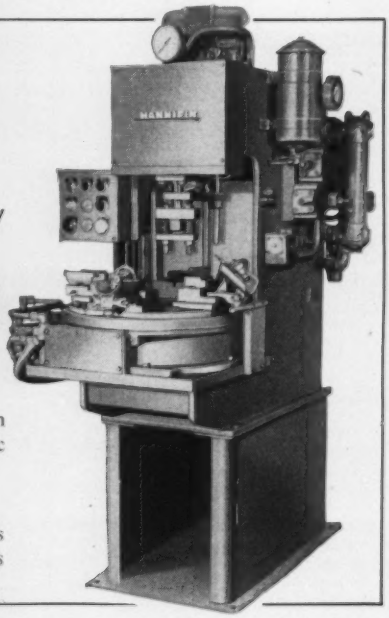

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Circle 723 on Page 35

Weighing System

Exact Weight Scale Co., 541 E. Town St., Columbus 15, Ohio—2 page pamphlet—Bulletin 3347-A provides details on a basic weight classification system for process, quality, and cost control. Product weighing is done on a Shadograph scale employing an optoelectrical principle of frictionless weight indication. Visual and electrical outputs are provided. Applications of the system may range from simple sampling techniques to closed loop feedback control for sorting and separating products weighing up to 100 pounds into multiple weight groups. Recording, counting, and signaling functions are performed by the system.

Circle 487 on Page 35

Digital Computer

Packard Bell Computer Corp., Subsidiary, Packard Bell Electronics, 1905 Armacost Ave., Los Angeles 25, Calif.—6 page pamphlet—Data on a high-speed digital computer, designated pb 250, are provided in Bulletin SP-100. This solid state, general purpose computer can function as an integrating element for a wide variety of systems. It features an operating speed up to 41,666 instructions per second and a memory capacity that can be expanded from 2320 to 15,888 words. As an off-line data conversion system, the computer can edit, sort, and format data for entry into another computer.

Circle 488 on Page 35

Ammonia Dissociators

Rolock Inc., 1350 Kings Highway, Fairfield, Conn.—2 page pamphlet—Ammonia dissociators, available in capacities of 300, 500, 700, and 1000 cfh, are described in Catalog Section 25. These dissociator units have maintained 99.985 per cent dissociation, leaving only 150 parts per million of residual ammonia. Catalog includes a flow diagram and details construction features of the devices such as twin Inconel catalyst chambers and reaction coil, and dual-purpose heat exchangers which preheat incoming ammonia vapor while cooling the dissociated gas.

Circle 489 on Page 35

Packaging Machinery

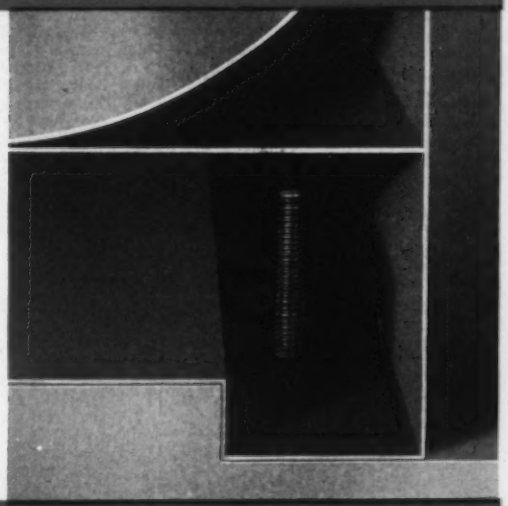
Food Machinery & Chemical Corp., 4900 Summerdale Ave., Philadelphia 24, Pa.—4 page pamphlet—Bulletin P-813 provides details on several types of packaging equipment: Auger filling; casing; pouch forming, filling, and sealing; check weighing; contour wrapping; carton filling; box, tray, and lid forming; and setup box-making. Photographs accompany the various descriptions.

Circle 490 on Page 35

Bar and Chucking Automatics

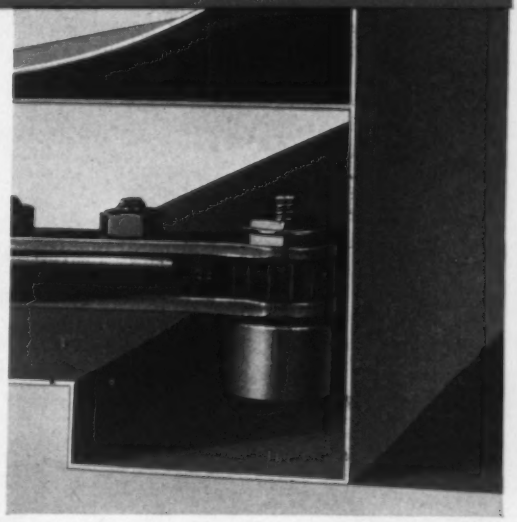
National Acme Co., 170 E. 131st St., Cleveland 8, Ohio—64 page handbook—Bulletin CA-60 shows how multiple spindle bar and chucking automatics permit the performance of a wide range of machining operations. A range of normal operations, plus many operations normally considered secondary, are clearly illustrated in 39 bar machine and 18 chucking machine applications. Four, six, and eight-

the most difficult fastening jobs . . .



Running a nut down on a stud is a very simple job, unless the stud is confined in a deep recess where a straight tool can't reach it, and where an angle tool won't provide the necessary clearance for the stud.

. . . can be simplified with APEX Fastening Tools



In this case, you merely put an Apex bolt-clearance type socket, designed for use with ratchet wrenches, on the tool, and you'll find you're right back to a very simple nut running job.

That's the way it goes with the difficult fastening jobs . . . Nearly all applications can be handled easily and economically with one of the more than 5,000 stock types and sizes of Apex Nut Running Tools. And for those few unusual applications, "we quote promptly on specials."

If you fasten anything with nuts, bolts or screws, write, on your company letterhead please, for **CATALOG 30-A** Nut Running Tools, ¼" to ⅝" square, hex drives. **CATALOG 30-B** Nut Running Tools, ¾" to 3½" square, hex drives. **CATALOG 30-C** Screwdriving Tools.

APEX FASTENING TOOLS

SCREWDRIVING • NUT RUNNING • SPECIAL

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Circle 724 on Page 35

spindle bar machines range in capacities from 7/16 to 7¾ inches. Chucking machines can be arranged for double indexing thus permitting both ends of the piece to be machined simultaneously in a single setup.

Circle 491 on Page 35

Flame Hardening Equipment

Air Reduction Sales Co., Div., Air Reduction Co. Inc., 150 E. 42nd St., New York 17, N. Y.—12 page booklet—Line of equipment used to solve various problems of oxyacetylene flame hardening is discussed in Brochure ADC 704A. All available equipment for the process is covered, from standard heating torches and tips to water-cooled flame hardening torches and gear hardening equipment. A portable machine carriage that operates on a tongued and grooved steel track is described. Designated as Radiagraph, this machine is ideally suited as a torch carrier for flat surface and gear hardening operations.

Circle 492 on Page 35

Torque Actuator

Ex-Cell-O Corp., Greenville Plant, 945 E. Sater St., Greenville, Ohio—4 page pamphlet—Bulletin 266013 illustrates and describes a midget Rotac torque actuator. This actuator uses hydraulic or pneumatic pressure to produce rotary reciprocating movements. It is used for light-duty applications in instruments, computers, switches, carton construction machines, and parts handling devices. A mounting diagram is included.

Circle 493 on Page 35

Decade Counter Modules

Electronic Tube Div., Burroughs Corp., Dept. LR-1, P. O. Box 1226, Plainfield, N. J.—4 page pamphlet—Detailed Bulletin 1002 contains data on Beam-X decade counter modules, Models DC-111-A and DC-111-B. These modules have been designed as plug-in units for use in electronic counters, automation and test equipment, machine control, and computers. They can be directly cascaded and can be driven by a 12-volt signal, making them compatible with existing transistor logic circuits. Their electronic and visual outputs permit them to be used as preset or variable scale counters. Diagrams illustrate constructional details of the units as well as electronic circuits.

Circle 494 on Page 35

Special Production Machines

Frauenthal Div., Kaydon Engineering Corp., Muskegon, Mich.—4 page pamphlet—Precision production machines for contour and conventional grinding, boring, and turning are described in 900 Series Bulletin. Covered by this bulletin is a custom designing service, based on building block techniques, to provide vertical machines in many configurations to meet customer requirements. Standard and optional features, including tracer control and numerical control, are described.

Circle 495 on Page 35

Resistance Welders

Federal Machine & Welder Co., Warren, Ohio—12 page booklet—Data on a line of resistance welders are provided in Bulletin BT-60. Spot, projection, seam, roll seam, portable welders, aircraft spot and seam, flash, multispot and automated machines are covered. Photographs of various models and typical product applications are provided.

Circle 496 on Page 35

Composition Analysis System

Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus 2, Ohio—12 page booklet—Principles upon which continuous, noncontacting measurement of fluids in pipes is achieved are covered in Bulletin CA-860. AccuRay composition analysis systems use radioisotopes to detect changes in specific gravity, per cent solids, concentration, or related quantity of materials conveyed in pipes. Such processes as kiln feed, blending and mixing, bulk density, fluidization, heavy media separation, and distillation are controlled by these systems.

Circle 497 on Page 35

Static Relay

Norbatrol Electronics Corp., 356 Collins Ave., Pittsburgh 6, Pa.—4 page pamphlet—Bulletin provides data on an ultrasensitive bistable amplifer. With internal reference, unit is designated Model 100C008; without reference Model 100C007. This all-static device responds to input signals of 0.05 microwatt, ac or dc, and has a high power output of 24 volts dc at currents up to 1 ampere. Applications include uses such as speed controls for dc motor drives and alarm circuits to sense minute variations in temperature, pressure, radiation level, light intensity, etc.

Circle 498 on Page 35

Automatic Turret Lathe

Machine Tool Div., Jones & Lamson Machine Co., Springfield, Vt.—4 page pamphlet—Bulletin GL-6020 contains information regarding an automatic turret lathe designed for both bar and chuck work. This lathe features complete programming of all machine functions from a single staging panel mounted on the machine. It has a 21-inch swing over ways and 34-inch maximum distance from spindle to turret. Three speed ranges are available; 20 to 1000, 30 to 1500, and 40 to 2000 rpm. Feed range is from 0.750 inch per minute to 30 inches per minute for the saddle and from 0.375 inch per minute to 15 inches per minute for the cross slide.

Circle 499 on Page 35

Process Optimization

Computer Systems Inc., Culver Rd., Monmouth Junction, N. J.—26 page handbook—Form 80-105-003 is a report describing a new procedure for the correlation and optimization of chemical kinetics models with an analog computer. A least mean squares evaluation of the constants from observed data provides the correlation for the model development; the model is then optimized to determine the most economic operation conditions. A complete solution with an accuracy of ±0.1 per cent can be obtained for a given process in less than 3 minutes after the data have been set in a Dystac analog computer. The report shows how the

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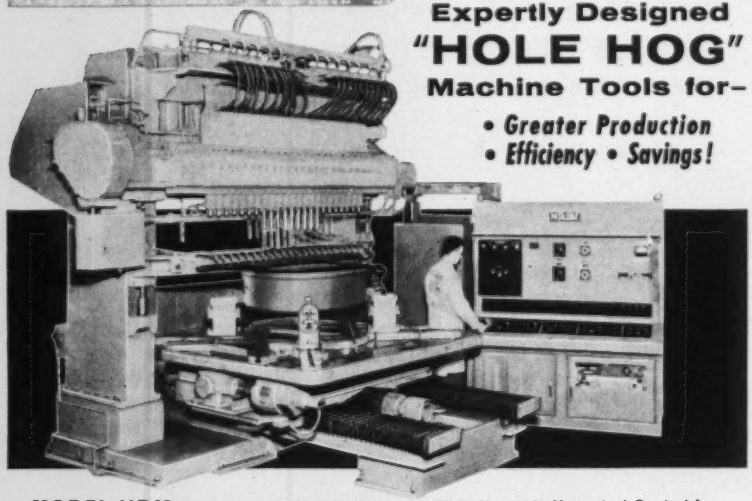

MODEL HD68 Tube Sheet Drilling Machine with Multi-Numetric Numerical Control for positioning of machine table in two directions and for selection of spindles. Information on punched tape permits automatic drilling of a complete hole pattern in a tube sheet without interruption.

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REPRESENTATIVES IN PRINCIPAL CITIES

115

constants may be evaluated for a two stage, constant pressure chemical reaction from isothermal pilot plant data. Complete mathematical derivations are included and are related to the computer program by wiring diagrams.

Circle 500 on Page 35

Positioning Control

Danly Machine Specialties Inc., 2100 S. Laramie Ave., Chicago 50, Ill.—4 page pamphlet — Bulletin PC-1 presents information on a positioning control system. Two standard forms, Type A where constant speed adjustment is required and Type B where variable speed adjustment is necessary, are discussed. Diagrams are included to show single speed connection and two speed connection. Also illustrated by diagrams are mounting dimensions for system components including a power panel, position setting device, position sensing device, and a direction controller.

Circle 501 on Page 35

Assembly Equipment

Dixon Automatic Tool Inc., 2300-23rd Ave., Rockford, Ill.—6 bulletins—Bound pamphlets contain data regarding a line of assembly components and equipment. Bulletin AP-B2 describes an Auto-Positioner for assembling small parts automatically. Details on an Auto-Torque driver for driving screws and nuts automatically are given in Bulletin SD-B1. Bulletin MC-B1 and ES-B1 cover, respectively, a compact unit for controlling pneumatic double-acting cylinders and a line of parts escapements. Diagrams in Bulletin MS-B1 illustrate standard mounting structures, and Bulletin FE-B3 provides data on a parts feeder. Model FE-103, that is capable of handling up to 200 parts per minute.

Circle 502 on Page 35

Indexing Machine Chassis

Swanson-Erie Corp., 814 E. Eighth St., Erie, Pa.—8 page bulletin—Brochure describes operating features of two series of turret indexing machine chassis. Both series are designed to provide intermittent motion for multiple station, automatic assembly and processing operations and are manufactured as basic units around which special automatic machines can be developed. Series H is a heavy duty chassis. Series K is equipped with a center column for applications requiring inboard tooling. This model is particularly adaptable for special machine applications such as those involving drilling, tapping, reaming, and milling.

Circle 503 on Page 35

Continuity Testers

Autonetics, Div., North American Aviation Inc., 3400 E. 70th St., Long Beach, Calif.—4 page pamphlet—Bulletin 518-G contains data on a line of electrical continuity testers designated NIFTE. These testers are available in increments of 500 test circuits and can qualify a minimum of 2 or a maximum of 18,000 wires. Neon bulbs on the unit's console flash instantaneously to indicate missing or mislocated wires. With the equipment, continuity checking of each wire to every other wire in a product can be conducted at rates from 1 to 20 tests per second, depending upon the number of wires per connector pin.

Circle 504 on Page 35

Computer Application Report

Computer Div., Bendix Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.—8 page application report—Uses of a general purpose computer in the mechanical engineering field are reviewed in application report brochure No. 12. The report covers applications of the digital computer, designated G-15, by 27 highly diverse companies and mechanical engineering firms.

Circle 505 on Page 35

Tracer Flame-Cutter

Linde Co., Div., Union Carbide Corp., 270 Park Ave., New York 17, N. Y.—8 page bulletin—Booklet F-55-040 provides data on an automated flame-cutting machine that enables intricate metal parts to be easily reproduced from simple pencil sketches on ordinary paper. The Oxweld CM-56 features a cross roll drive principle that takes the drive wheel off the tracing table. It is designed to flame-cut intricate parts up to 10 ft wide of any length or thickness. Largest available model may be equipped with up to 8 torches to cut widths of 10 feet. Two smaller models are available for use with 4 and 6 torches for cutting widths of 62 and 90 inches.

Circle 506 on Page 35

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Handles any job in your shop using 3/4" to 1/8" connections – from the air line to the air tool – eliminates any need for various size couplings in hook-up – makes it easy to keep stock of parts in balance – holds inventories to a minimum.

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Circle 726 on Page 35

SINGER* NUMERICAL CONTROL

The Singer Numerical Control System represents the most direct approach to point-to-point positioning yet conceived. It offers simplicity, reliability and economy, reducing costs of maintenance, labor and downtime.

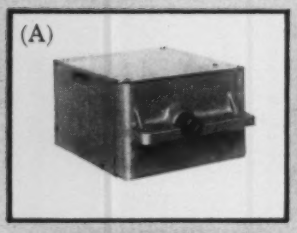
A major feature of Singer automation is modular design. This makes it possible to assemble basic units in a variety of control systems.

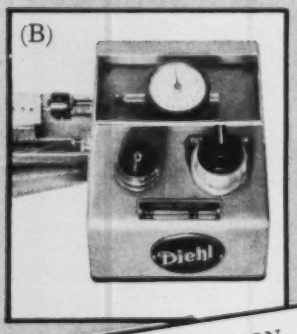
AUTOMATIC POSITIONING SYSTEM

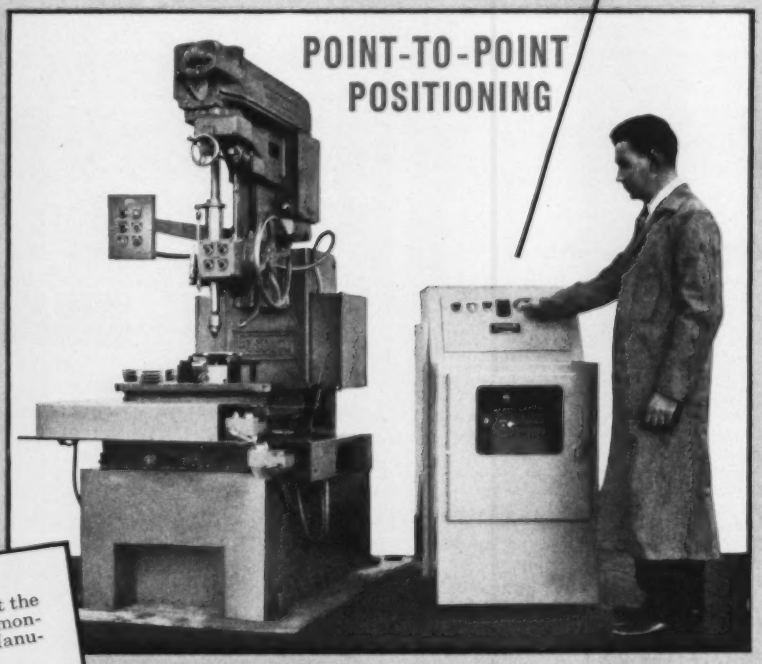
For example, because of the simplicity of Singer modular design, an Automatic Positioning System can be furnished immediately as standard for use on a drilling machine to drive and position the work table and saddle motion.

All that is required is a motor drive assembly (A) and a position indicator control (B) on each axis. This system will then operate with standard end measures.

At any future time, tape control can easily be added to provide a complete Singer Numerical Control System, as shown below with a Fosdick 5BM Sensitive Drill Press.







AN INVITATION

You are cordially invited to visit the Singer Numerical Control demonstration room at the Diehl Manufacturing Company

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AUTOMATION abstracts

RECORDING PERFORMANCE DATA

By J. D. QUINN
Consultant Supervisor, Maint. Engr.
E. I. du Pont de Nemours and Co. Inc.
Wilmington, Del.

IT is a bit startling that high percentages of nonproductive time continue to exist in spite of the recognition of maintenance-downtime causes and the taking of corrective action. This can be particularly disturbing if considerable effort has been expended in method studies, time studies, and other studies to improve effectiveness. While these may have resulted in some improvement, for a number of reasons many other causes of machine downtime may have been dismissed as being inherent, or may have been accepted as normal situations. Equipment shutdowns of very short duration, such as for machine adjustment or clearing a product jam, may not be considered significant individually. Collectively they can become serious.

It is very important that factual data be available concerning potential equipment utility or output to have both effective production planning and high utilization of equipment. If based on design capacity with a modest allowance for downtime, the conclusions regarding potential equipment utility could be too optimistic, or if based on previous performance, too conservative. Underestimating downtime could lead to scheduling problems, and overestimating downtime could lead to acceptance of conditions—many of which might be correctable.

When potential equipment utility is considered, certain restraints are established by design limitations. Reasonable life expectancy and reasonable cost must be considered. This may dictate that commercially available equipment be used that does not have all the features that the designer would like to include, and that does not eliminate all possibilities of equipment maintenance or equipment shutdowns.

Material limitations, particularly in chemical plants, are sometimes as important as equipment-design limitations. For example, there are still many situations where wood-stave or steel tanks are the most logical choice, although it is known that some maintenance will be required after a relatively short period of operation.

Process and quality control limitations may exist when the machine loading and machine speeds are well within design limits, and the restraint in this situation is the physical characteristics of the product being manufactured. Until improvements can be made in the composition or characteristics of the product, and the mechanical limitations improved, there is little that can be done to increase the rate of productivity. In this situation the effects of maintenance can be the most significant segment of process equipment downtime and, if the rate of production cannot be increased, it is possible that the downtime can be decreased. Downtime for mechanical reasons may include machine adjustments, minor repairs, or replacement of components, major overhauls, or unplanned failures. The total effect can be important.

When downtime occurs frequently for the same reason, the condition may be due to poor quality workmanship or because of changes in operating conditions. In the latter case the equipment may be operating at two to four times its original rate. Although the original design may have been adequate, the incremental in-

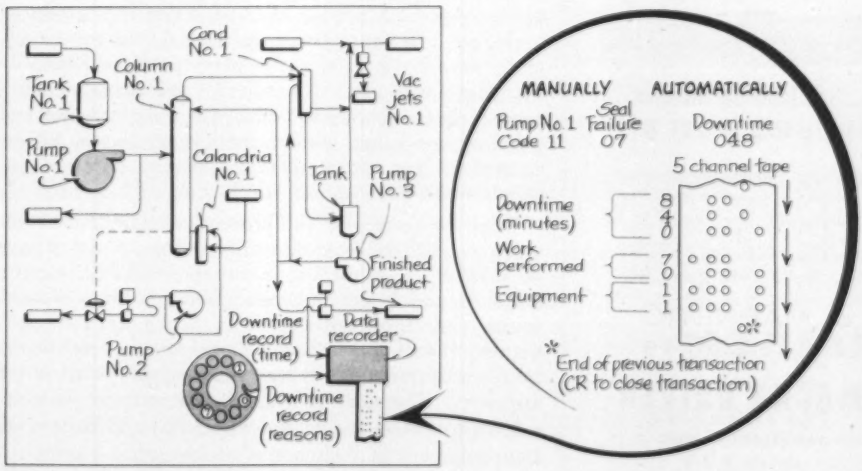
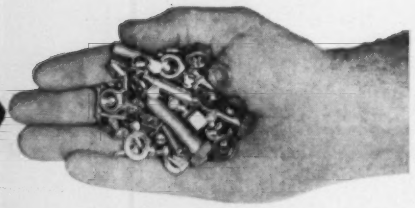


Fig. 1 — Diagram illustrates application of specially designed data gathering equipment. Duration of downtime is automatically sensed for punching into tape. Data as to what failed and why it failed are entered on dial for subsequent punching into tape.

WE CAN PUT THIS-



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Circle 729 on Page 35

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creases may have been so small and gradual that the total effect on components was not considered.

Too Much Maintenance

Preventive maintenance, which was unique in the 1930's, is now accepted as a sound practice in many industries but is frequently applied too often. In a recent review of a routine monthly inspection procedure it was found that 300 items were included, many of which required dismantling of subassemblies. Only three of these items required inspection at the frequency prescribed, and then only on a term basis to establish rate of wear under the particular set of operating conditions.

In cases of this kind, it should be determined whether anything is accomplished. Furthermore, if the mechanic assigned is not able to duplicate the original conditions in reassembly, he may introduce rather than eliminate maintenance problems. If insufficient information is available about past experience, the approach to preventive maintenance should be very conservative. Otherwise, an occasional planned shutdown is displaced by a high number of planned shutdowns requiring considerably more production equipment downtime.

Efforts to increase equipment utility are usually only as effective as the completeness of the information, and apparently there is no short cut. Adequate data and systematic analysis of these data must be accumulated to establish reasons for all equipment downtime.

If downtime for maintenance can be accounted for and separated, opportunity is provided to examine the conditions and to evaluate the possibility of increasing productivity through this route. The most important effect of downtime for maintenance could be lost production, but there is also the possibility of loss through substandard production, or both, resulting in a considerably higher product cost. If the number or frequency of maintenance problems is reduced, it may be possible to increase the rate of production as well as to increase available operating time.

Problem solution requires sufficient data and the analysis of these data by qualified personnel. The work should be undertaken by experienced engineers, or, if engineers-in-training are assigned, they should have close direction. In the study, the adequacy of components for service at the present operating rates should be considered. Materials of construction now produced in higher volume at lower cost should be considered, as it may have been a marginal decision originally that they not be used. The effectiveness of maintenance procedures for repairs and preventive maintenance and the frequency that work is performed should be examined, if this information is available. It is not unusual to find that it is not.

Extensive programs for preventive maintenance involving considerable equipment shutdown and cost may be carefully scheduled to occur at 1-month, 3-month, 6-month, and 1-year intervals without outlines of work to be performed other than a listing of inspection points. It will also be found that there is a tendency to inspect all equipment at least once a year—why, is not apparent. The same individuals who prepare these extensive programs would not dismantle and inspect all the equipment in their homes at least once a year.

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If study indicates that an investment should be considered to reduce equipment downtime and action is taken, it is important that there be some method established to measure the results. Development of history concerning all reasons for production equipment downtime and the justification for corrective action can be very laborious and time-consuming. Most plant systems were not established with this requirement in mind and many sources may have to be used to develop sufficient data—cost records, shutdown reports, operating logs, and other records. Most equipment-history cards do not account for the numerous short-duration shutdowns because of the tremendous amount of clerical assistance that would be required.

Recording Downtime Data

About five years ago recording equipment, used for other purposes, that would provide information concerning equipment downtime was investigated. It was found that a complete record could be accumulated of shutdowns for all reasons. However, the large number of components and reasons for shutdown had to be coded and then manually rearranged to accumulate time by reasons and to identify the most significant problems.

What was needed was a simple means of recording data and converting it to computer language so that the considerable amount of detailed information could be processed without clerical assistance. A market search revealed a considerable number of recording devices and suitable computers. Equipment that would bridge the gap between recorders and data processing equipment could not be located, so a unit was developed to meet the requirements. Similar units will probably be on the market within the next year or so. Through extended use of the recording equipment, reliable information is being developed concerning all problems associated with operation of many process units in the plants.

A chemical processing system illustrates how equipment of this type can be used, *Fig.* 1. The recorder is shown responsive to a pressure-sensitive transmitter in the finished-product line, although in a mechanical application it could be actuated by a normally open relay in the power circuit when the circuit became de-energized. In the example, with a drop in pressure below an acceptable operation limit, or with a complete shutdown of the unit, the recorder is energized and starts to record time. In this system of interdependent components pump No. 1 is coded as No. 11 to distinguish it from two other pumps in the system, and it is assumed that pump No. 1 failed because of a problem related to the mechanical seal. Upon replacement of the seal and startup of the process, an alarm in the recorder is activated signifying that the operator is required to dial in the reason for shutdown.

A section of tape is enlarged in the illustration to show how the complete data appear on the tape. Pump No. 1 is coded No. 11; seal failure is coded as 07, which can be one of 100 reasons for failure of the unit. In this particular case as many as 48 intervals of downtime have accumulated (048). When the operator dials in 1107 to record location and cause, this is automatically encoded in the standard five-channel tele-

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Magnetic pickup built for heavy-duty service in industrial, military and experimental applications where space is limited and reliability essential.

Model 2043
Magnetic pickup designed to sandwich between a tachometer generator and an AND 20005 engine mounting pad. Rear flange accommodates standard 3-phase electric tachometer generator.

Model 1312 Electronic Tachometer

Model 2040
Compact lightweight magnetic pickup designed for mounting to an AND 20005 engine pad . . . also for checking other rotating devices which require high resolution per revolution.

Model 2095
Photo-electric pickup is ideal for low speed applications . . . process control . . . measurement of linear dimensions and angular movement.

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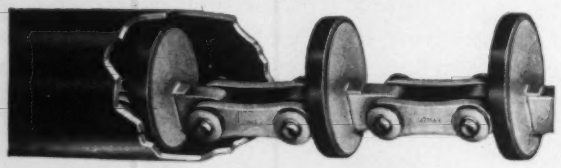

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In system-performance analysis information is at our disposal concerning cause and effect; the problem is to identify the cause. Knowing the cause, and correcting it, rather than accepting and correcting effects, appear to be logical courses of action to improve productivity.

From a paper entitled "Equipment-Performance Analysis" presented at the Annual Meeting of the American Society of Mechanical Engineers, New York, December, 1960.

COMPUTERS AND SMALL COMPANIES

By G. A. WESLEY
Bendix Computer Div., Bendix Aviation Corp.
Los Angeles, Calif.

IF we are to be able to consider the use of digital computers by a small company, it seems obvious that the more powerful equipment would entail prohibitive costs for the smaller operation. Attention to this problem has been given by many organizations. There are actually three alternatives which may be taken. Each has its advantages, with rather complex factors making the final determination. The first of these alternatives is to utilize a computer service center on an hourly basis. The more expensive systems must be kept continually busy, one, two, or even three full shifts a day to make their use pay off. Because a large, extremely high speed computer can perform many thousands of operations per minute, a computer service organization can serve many, many customers at hourly rates well within their budget. The small businessman can then take advantage of the most powerful equipment available without any investment of capital or personnel.

Problem analysis and programming service is available through these centers. The consideration is purely one of economics; if the job to be done can be analyzed, programmed, and solved at a cost below that of present manual methods, it can be considered on a service basis. In my opinion, the chief disadvantage in using computer service centers exclusively is that a high degree of interest in the use of computers for many different programs is not instilled due to the specialized nature of the problem at hand and the fact that equipment and programming talent is not

available within the company.

The second alternative is one which has only recently been exploited to any great degree. That alternative is the sharing by several organizations of a larger scale computer than could be afforded by one organization. This shared service center plan is best illustrated by the success of project SPAN in Hartford, Conn. Although this is an example of three sizable casualty insurance companies joining together to share the benefits of a digital computer system, the same principle can be applied to allow the smaller businessman the benefits of a larger scale computer system.

The third alternative is the obvious one of installing a computer system within the organization. As I mentioned before, this can be done by either leasing the equipment or by outright purchase.

The consideration of lease versus purchase is primarily based on the needs of the organization considering the equipment. Are these needs predictable enough to allow a purchased system to be amortized over the necessary interval of from 3½ to 5 years? A very important consideration when investigating these needs is to compare their likelihood of expansion with the expandability of the equipment being considered. Many of the more progressive computer systems can be expanded far beyond their initial basic form. The life span of the equipment must be such that it can reasonably be expected to outlive the amortization period. In many instances Bendix users have long since written off the cost of the G-15 and are now enjoying essentially cost-free computer usage. One of our first machines to be delivered recently logged its 67,000th hour of service and is still in active use. The majority of the computer systems, however, are installed in private enterprise today on a lease basis of one year's minimum duration. For many businesses and many unpredictable situations this is the only factor that could allow installation of an on-site computer system.

For the smaller organization, lease or purchase dictates that smaller scale systems be considered. Several extremely efficient systems are presently being marketed that can economically serve the smaller businessman. Although certain restrictions are placed on the user of less powerful equipment, the availability on site of equipment at all times will usually more than offset the lack of speed.

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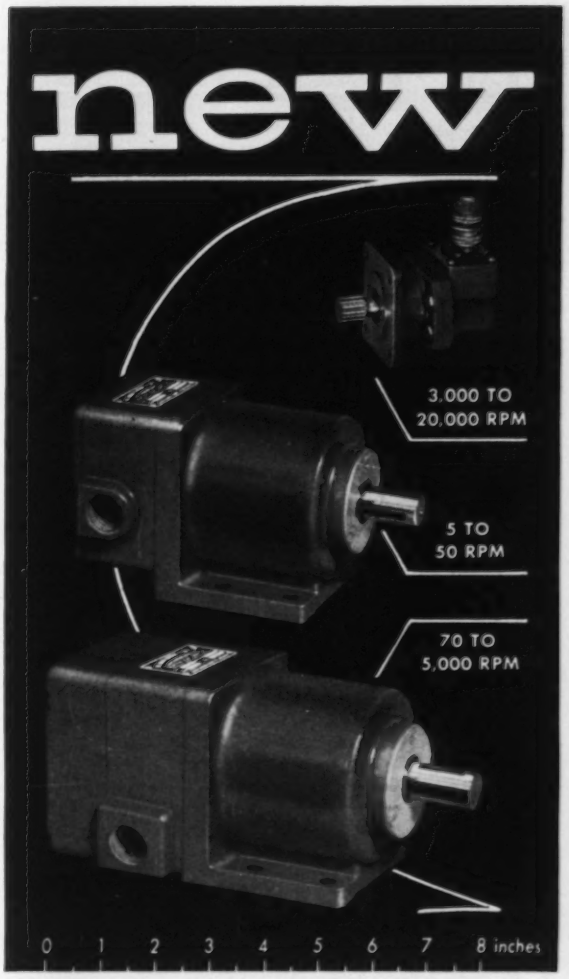
2. Where so many solutions are possible for a specific problem that determination of the best solution by manual computation is not economically feasible.
3. Where the accounting or financial staff is spending too much time turning out repetitive reports.
4. Where engineers are spending too much time on routine repetitive calculations.
5. Where the engineering staff is not large enough to take on added work and expansion of staff is not desirable.
6. Where large amounts of data are available but are useless because they are not correlated or tabulated in a useful form.

What types of problems are representative of those



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best suited to the application of digital computers? The first are engineering problems. Complex engineering problems must often be solved before a given product can be manufactured. Typical engineering problems that can best be solved by computers include stress analysis, heat and pressure calculations, vibration analysis, engine and lens design. Most important of all, small manufacturers can now enter new fields that were closed to them before the advent of computers.

Another is the application of computers to problems of management analysis. For example, such problems as deciding where to locate a new plant or branch operation, taking into consideration the expected customer demand, transportation, distribution, and the many other factors that affect costs and profit. Or deciding whether to make or buy components—which items or parts to manufacture, which to buy, when, why. Also the forecasting of sales and market potential; performing market research by determining sales probabilities in different geographical areas for different products.

Probably the most important of the types of problems are those of production. Small manufacturers have been making increased use of computers to solve complex production problems. Shop loading and over-all production scheduling—designing schedules to meet expected sales and varying these schedules in accordance with fluctuations of the actual conditions. Blending or mixing problems, finding the best combination of ingredients or raw materials, and another application closely allied, the reduction of trim losses, minimizing waste during the forming, shearing, slitting or punching of rolls and sheets of material to produce various needed sizes.

From a paper entitled "Use of Computers By Small Companies" presented at 1960 Western Engineering Conference of American Society of Tool and Manufacturing Engineers, Los Angeles, November, 1960.

COMMENTS ON TECHNOLOGICAL CHANGE

By M. E. ROBERTSON
Chairman of the Board
Oneida, Ltd.
Oneida, N. Y.

EVERYONE agrees that the wage-price squeeze and intense competitive pressures, both national and international, under which most companies find themselves, force cost reduction by every possible means. The challenge is to accept the idea that automation is necessary and the problem is how to accomplish this within capital limitations.

As to the challenge: Industry must accept the fact that technological change—improvements in operating methods, in manufacturing processes, in selling techniques—is vitally necessary if we are to successfully meet the competition of domestic and of foreign competitors and if we are to hold our present standard of living, to say nothing of increasing it.

Technology and science are world-wide today. Auto-

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mation is not confined to the United States. Thus, when it is harnessed to lower foreign wages, it spells not alone the loss of exports but, as well, some portion of the domestic market. The automobile is one of many examples that might be mentioned.

As to the problem: The question that is uppermost in the minds of our legislators, at both federal and state levels, our educators, our labor leaders, our economists, and the average informed citizen is, "What are we going to do about the unemployment which results from technological change?" This is the question that needs careful analysis and answer. It will be increasingly raised in the months ahead and industry will be asked to supply a substantial part of the answer. Industry cannot, must not, side-step this issue. On that subject, here are some pertinent comments.

We know that most unemployment is caused by other than automation or technological change. Other causes are: Health, discipline, compulsory retirement, marriage, maternity, home needs, moving out of the area, preference for unemployment insurance rather than work, a bankrupt company, mergers, company moves to another location, smaller share of market due to domestic competition, smaller share of market due to foreign competition, strikes, boycotts, seasonal type of business, unavailability of materials owing to strikes or national emergencies, termination of defense contracts and, yes, labor's own attitude in reference to wages and fringe benefits.

It would not be difficult for our state authorities to determine the percent of unemployment caused by true technological change. For example, in New York before an unemployed person can get unemployment insurance, the latest employer must sign an information form. There is a question on that form which employers must answer, namely, "Why was John Jones or Mary Smith laid off or discharged?" The answer could be compiled and checked against an honest definition of technological change. Then we could see the extent of the problem. Sound conclusions can only be reached after the true facts are known.

Just as technological change creates new operations and requires new skills, so it also can create temporary unemployment. This, in turn, indicates the need for renewed emphasis on in-plant training and retraining and more out-plant training in high schools and colleges for technicians, professional, and managerial people. Usually, the employer knows what new skills will will be required some time in advance of the proposed change in method of operation. Industry must give as much thought to the effects on personnel as it does to instituting the change.

Incidentally, this problem has not been overlooked by industry. We have learned much, as manufacturers, about how to handle the problem internally, through education of our people, through use of personnel techniques to assure a minimum of human suffering and dislocation and a maximum of benefits through utilization of higher skills at better paid and more stable jobs. We are doing, the evidence is clear, a significant job of adjustment everywhere. Perhaps we make the mistake of doing it so routinely that the public never knows about it.

From a paper entitled "Industry and Automation—the Challenge and the Problems," presented at the 65th

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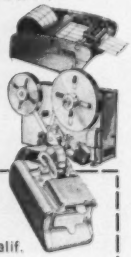

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Annual Congress of American Industry, National Association of Manufacturers, New York, December, 1960.

THE VERSATILE ROTAMETER

By SEYMOUR BLECHMAN
Vice President
Brooks Instrument Co. Inc.
Lansdale, Pa.

FAR from being outdated in this era of data handling systems, computer controls, and other highly sophisticated equipment, the rotameter has become one of the most utilitarian primary devices in the process industries. Rotameter sales in the United States will reach a volume somewhere around $14 million during 1960. The international rotameter market is estimated to be approximately $20 million, and expanding at the rate of 15 per cent a year.

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The versatility of the rotameter is such that the indicating models used to establish flow ranges in a pilot plant can be changed into transmitters when the process is ready to be put under automatic control. The change-over is accomplished by replacing the indicator with the appropriate extension; basic flow elements and calibration remain unchanged. Pneumatic and electric transmitting, integrating, and alarm extensions are available to equip the rotameter for use with controllers, annunciators, data handling systems, or digitizers.

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Based on a paper entitled "The Outlook for the Rotameter in Process Instrumentation", presented before the Tulsa Chapter, Instrument Society of America, November 1960.

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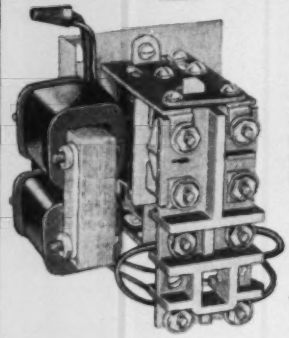

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new books

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By Kenneth E. Boulding, professor of economics, and W. Allen Spivey, associate professor of statistics, both of University of Michigan; 227 pages, 6 by 9¼ inches; published by Macmillan Co., New York; available from AUTOMATION; *$8.00 postpaid.*

Essays from seminar at University of Michigan examine developments relevant to the theory of the firm. Major area covered involves linear programming, operations research, and management science. Mathematics necessary for understanding in this area is presented in a manner requiring only elementary algebra as background. An analytical and graphical comparison of marginal analysis and mathematical programming is included to aid in developing understanding without use of advanced mathematical techniques.

MANAGEMENT GUIDE TO APPLIED INDUSTRIAL PSYCHOLOGY

By Bernard T. Lewis, manager, industrial engineering branch, Area Public Works Office, New York, Dept. of the Navy, and William W. Pearson, assistant director, Management Institute, New York University; 74 pages, 5½ by 8¼ inches, paperbound; published by John F. Rider Publisher Inc., New York; available from AUTOMATION; *$1.50 postpaid.*

Brief review provides some broad ideas of industrial psychology in general. Discussion includes personnel tests and principles of supervision and leadership, industrial counseling, and mental health in industry.

AUTOMATION AND THE WORKER

By Floyd C. Mann, survey research center, and L. Richard Hoffman, psychology dept., both of the University of Michigan; 272 pages, 5½ by 8¼ inches; published by Henry Holt and Co., New York; available from AUTOMATION; *$4.50 postpaid.*

Subtitled "A Study of Social Change in Power Plants," this is a report of an investigation into the effects of use of more automatic equipment in power plants. Comparison studies were made in two of a company's power plants—one a very modern unit, the other an older unit with approximately the same output. Though validity of the interpretations and extensions to automated processes in general may be questioned, this study examined many factors of general industrial interest.

INTRODUCTION TO MODERN NETWORK SYNTHESIS

By M. E. Van Valkenburg, professor of electrical engineering, University of Illinois; 489 pages, 5¾ by 9 inches, published by John Wiley & Sons Inc., New York; available

from AUTOMATION; *$11.75 postpaid.*

Text is written for a reader with the usual undergraduate knowledge of network analysis and the Laplace transformation. Background material is reviewed in the first two chapters, then positive real functions are discussed. Elementary synthesis procedures are presented for LC, RC, and RL, and RLC cases plus related topics for one terminal-pair networks. Following chapters discuss two terminal-pair network synthesis. Illustrative problems are included with each chapter.

Industrial Publications

TRANSISTOR MANUAL

Looseleaf, 329 pages, 5½ by 8½ inches; available from General Electric Co., Semiconductor Products Dept., Kelley Bldg., Liverpool, N. Y.; $1.00

Fifth edition of reference on transistors and application principles has been expanded with new chapters on tunnel diode theory and switching circuits, tunnel diode amplifiers, feedback and servo amplifiers, and test circuits. Chapters on silicon controlled rectifiers, power supplies, transistor specifications, and rectifier specifications have been revised and expanded.

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Looseleaf, 205 pages, 5½ by 8½ inches; available from Motorola Semiconductor Products Inc., Technical Information Center, 5005 East McDowell Rd., Phoenix, Ariz.; $2.00.

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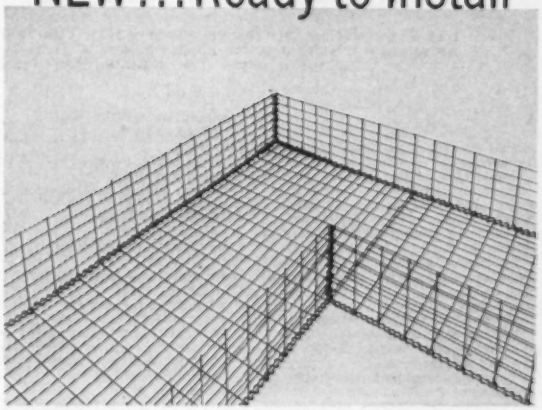

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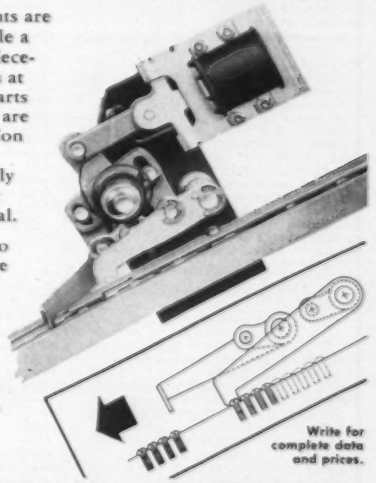

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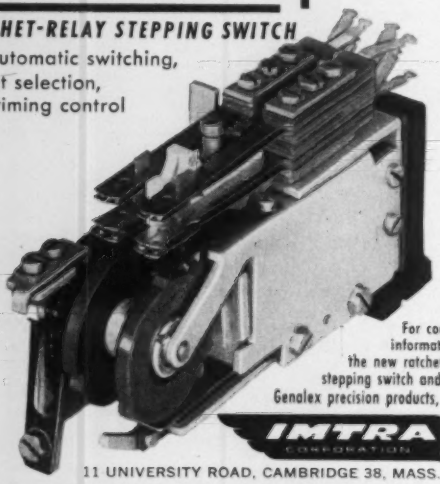

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Circle 748 on Page 35

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2290-P

VIBRATING SMALL MASSES

. . . We are searching for a miniature lightweight vibrator to incorporate in our Dry-Flow meter. The mass to be vibrated weighs 1½ pounds, and the vibrator desired must have a net weight of 6 ounces or less while producing 3600 vibrations per minute. Any help you can give us will be greatly appreciated. . .

President

CASE 2291-P

HANDLING TRANSISTORS AND DIODES

. . . We have been looking for someone who makes or sells automatic handling equipment for transistors and diodes. We are constantly asked for a solution to this problem, and if you can refer us to someone, we would certainly appreciate it. . .

President

CASE 2292-P

SOLDERING TYPE BARS

. . . We have just completed 9 automatic soldering machines which solder the type face onto the type bar on typewriter segments. We use a 4-station index table, and total cycle time per type bar is 0.06 minute. Our only chance to increase output of machines is to automatically apply the flux to parts at the second station. We need a means to supply approximately one drop of liquid flux, on demand, at a predetermined point in 0.04 minute. Valving etc. must be acid resistant. We thought perhaps you might be able to recommend a company that could help. . .

Methods Supervisor

CASE 2295-P

MOLDING GLASS COMPONENTS

. . . We are in need of a metal or a parting compound to be used in molding glass components. Maximum temperature experienced by the mold is about 550C. The system must operate so that no sticking is experienced between the glass and the mold when the glass is removed at about 100C. In addition, no acidic or basic byproducts may be given off during the heat cycle. If a parting compound is used, it may not leave a residue on the glass, and it should be good for several runs of the mold. It must be easily applied and easily removed when cleaning the molds. Various Inco metals, as well as flame-plated tungsten carbide on a stainless base, have been tried with little success. . .

Process Engineer

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P

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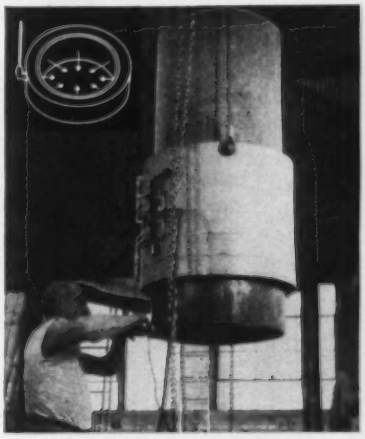
A new concept in critical Materials Handling



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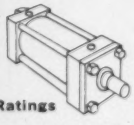

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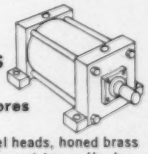

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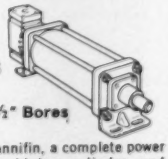

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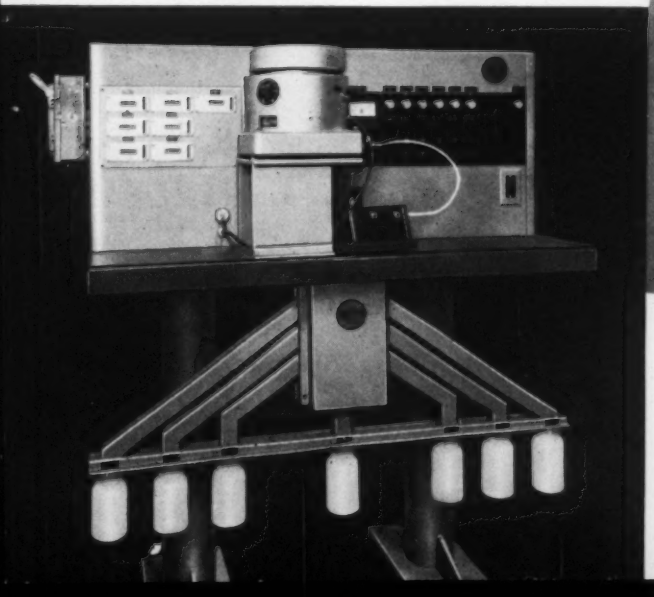

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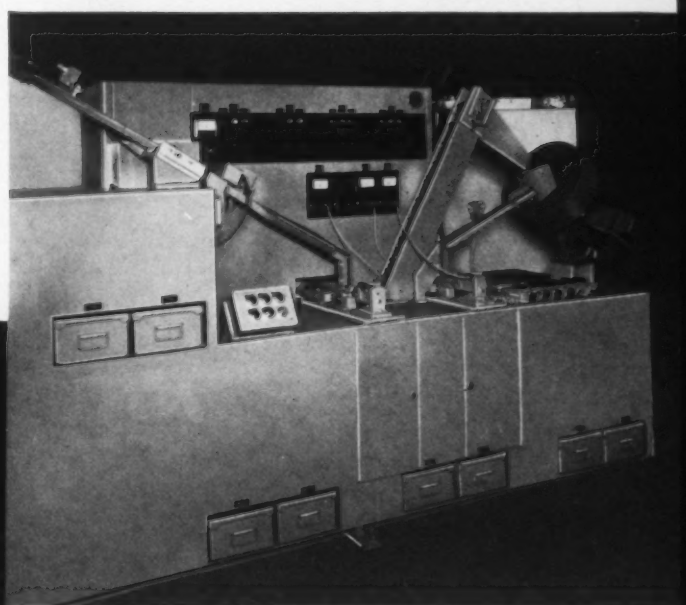

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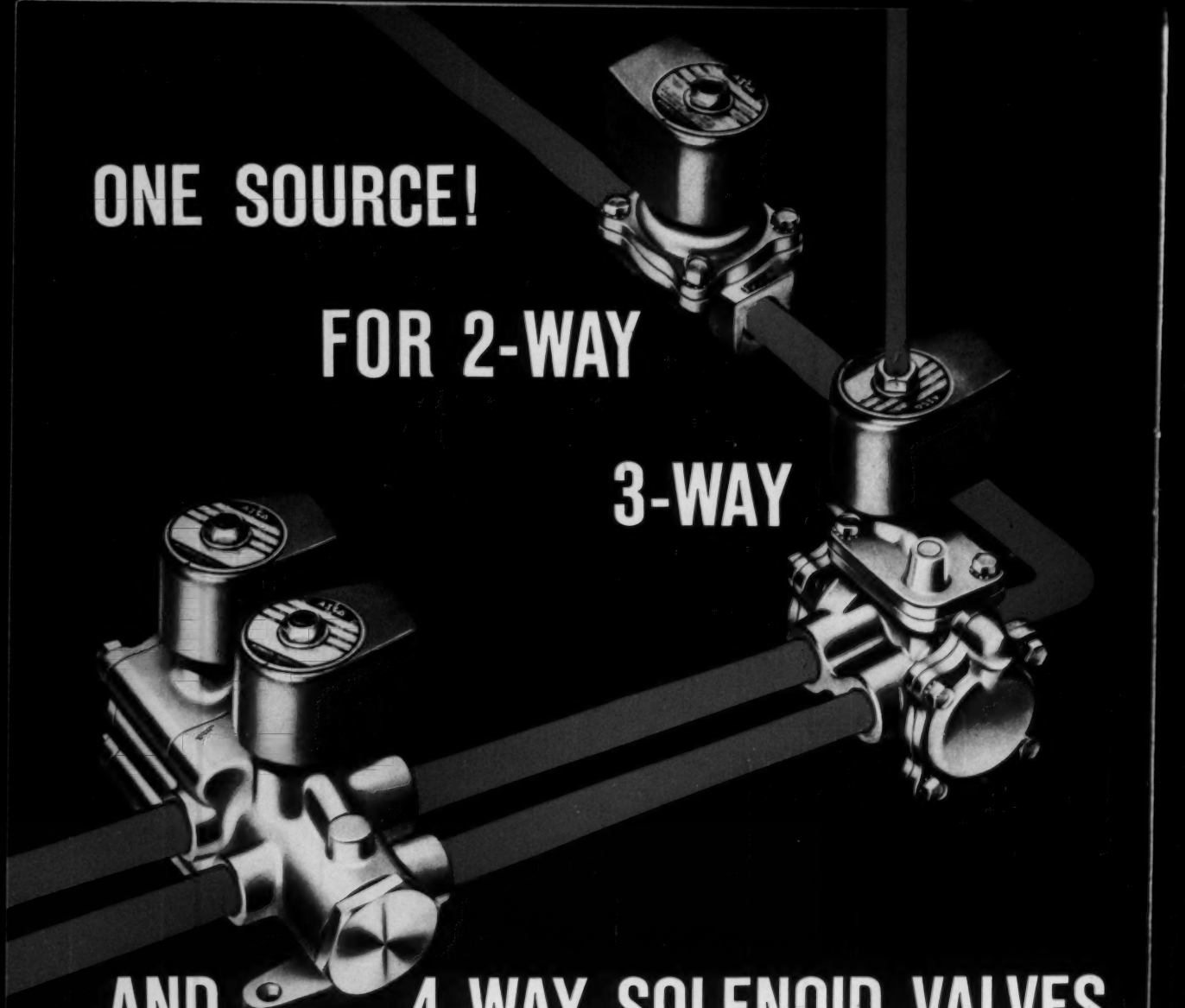

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